POWER

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Industrial Relations

The present industrial unrest has been precipitated largely by two factors—an attempt to compel collective bargaining, and the high cost of living—but underlying the whole movement is a force working toward readjustment of industrial relations.

Labor, having been denied in the past what it considered its rightful share in the fruits of industry, has taken advantage of conditions created by the war and, conscious of its strength, is now asserting itself.

Capital has found it easier to meet Labor's demands and pass the burden on to the consumer without getting at the root of the problem, with the result that the situation has become aggravated instead of better.

The problem is so complex as to almost defy solution, but certain conditions exist that must be wiped out before any progress can be made. Among these are:

The supposed law of supply and demand has fallen down, because

1. There is profiteering on the part of both Capital and Labor.

2. There are indications of attempts by Capital and Labor to limit production.

But rectifying these conditions will not alone effect a solution; certain fundamentals must be recognized by both sides.

1. In the final analysis all wealth is the product of labor, but not of manual labor alone, as is mistakenly argued by one class. The trouble has been in evaluating, respectively, labor of the hands and of the brain.

2. It is not enough to say that Capital and Labor are partners. Labor must be shown.

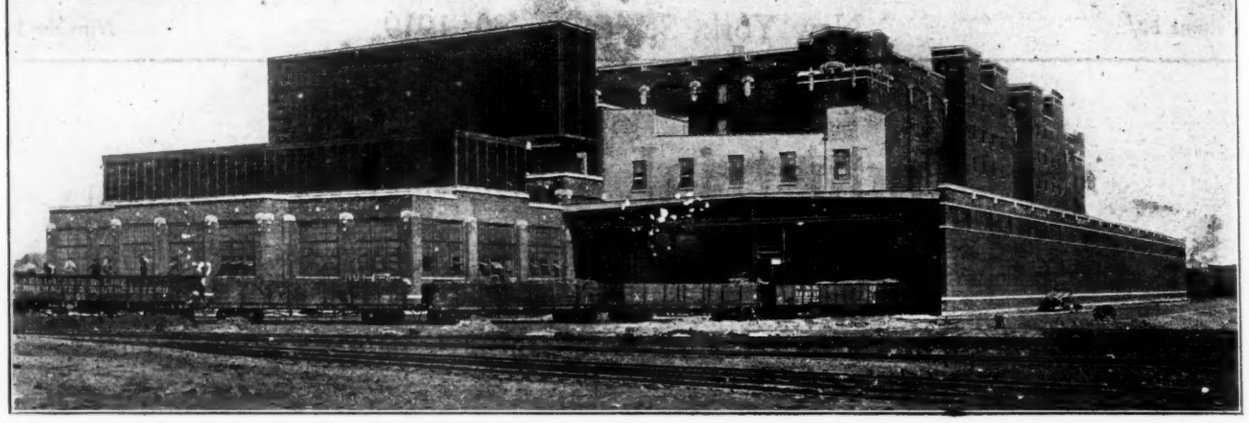
3. Management must not assume that it is accountable to Capital alone, and it can no longer regard labor as a commodity to be bought and sold.

4. On the other hand, Labor must be shown that its demands must not be such as to stifle the very industry upon which it is dependent for its livelihood.

5. Both Capital and Labor are responsible to the public.

With these facts in mind the speediest relief may be expected through increased production with Labor assured of an adequate wage, legitimate Capital a fair return, and initiative a reasonable profit.

LARGE GOVERNMENT STORAGE PLANT FOR CHICAGO



Substantial construction, heavily insulated, with daily storage capacity exceeding 58 million pounds. Complete refrigerating and ice-making plants featured by the use of synchronous motors driving by belt two boosters and three high-pressure machines with aggregate capacity of 1005 tons of refrigeration on zero back-pressure basis.

STORING frozen meat for the army and making ice to ship it are the services required of the new Government cold-storage warehouse located in the Central Manufacturing District at Hoyne Ave. and Thirty-ninth St., Chicago. Over 58,000,000 lb. of meat can be stored at one time, and more than this amount can be frozen and shipped each month. In this same locality are numerous storage depots, some temporary and others of permanent character, which the Government erected during the war. The last building to be completed is the new cold-storage warehouse, which is one of the largest and most attractive in the country. It was erected at a cost of $2,150,000, not including the land. The entire refrigerating equipment cost $900,000, so that the total cost, excluding real estate, exceeded $3,000,000. The original proposal was made in July, 1918. Work started on July 25, occupancy of the basement for storage began Jan. 20, 1919, and on Mar. 15 of this year the building was occupied for freezing purposes.

The building is a reinforced-concrete structure, six stories and basement, faced with red brick and trimmed with terra cotta, with a two-story wing addition in the rear for the ice plant and the refrigerating machinery. The main structure is 223 ft. wide by 323 ft. deep, the two-story and basement wing measuring 143 x 145 ft. There are also train sheds and unloading platforms with capacity for 50 cars at one setting. Including the additions last mentioned the total area of the building is approximately 586,000 sq.ft. and the volume 8,600,000 cu.ft. The total storage capacity approximates 58,250,000 lb. distributed as follows: 26,250,000 lb. to storage freezers, 8,000,000 lb. to sharp freezers and 24,000,000 lb. to ordinary storage. In general each of the six main floors is divided into four sections, a storage freezer being located at either end with two sharp freezer sections at the center. Cooling is effected by a direct-expansion ammonia system containing 800,000 lin.ft. of 2-in. pipe. In the storage freezers a minimum temperature of 10 to 15 deg. above zero is maintained by one lineal foot of piping to 18 cu.ft. of volume. In the sharp freezers, with temperatures ranging from 10 to 15 deg. below zero, the ratio is 1 to 3.

There are railway tracks on either side of the building. On one side cars are unloaded into storage and on the other side loaded from storage, so that there need be no conflict between the two operations. On each side there are four electric freight elevators of the worm-and-gear drum type, each having a car platform 9.5 by 13 ft. and a capacity of 6000 lb. The car contains 32 lin. ft. of track with hanging capacity for 4000 lb. of beef in quarters, and on the basis of eight trips per hour will carry 16 tons of meat. These elevators are spaced symmetrically with respect to the sharp freezer rooms, being located across the vestibules serving them. A complete interconnecting trolley track layout for all floors except the basement facilitates the handling and storing of the meat.

Cork-Board Insulation of Storage Space

To insulate the storage space the enormous quantity of 1250 tons of cork board was used. In the main building the first and fourth floors are insulated by 6 in. of cork in two 3-in. layers and the roof by 8 in. of cork in two 4-in. layers. The outside walls are insulated with 6 in. of cork in two 3-in. layers and the dividing walls between the freezer storage and sharp freezer rooms have 4 in. of cork in two 2-in. layers. At the first and fourth floors the columns were insulated with cork to a height of 5 ft. 6 in. and 3 ft. respectively, and in the basement column heads were insulated also with cork.

All exposed cork surfaces were plastered with cement mortar. The floor insulation was set in hot asphalt throughout. To apply the insulation to the walls, the first layer of cork was set in cement mortar and the second layer was set in hot asphalt and secured

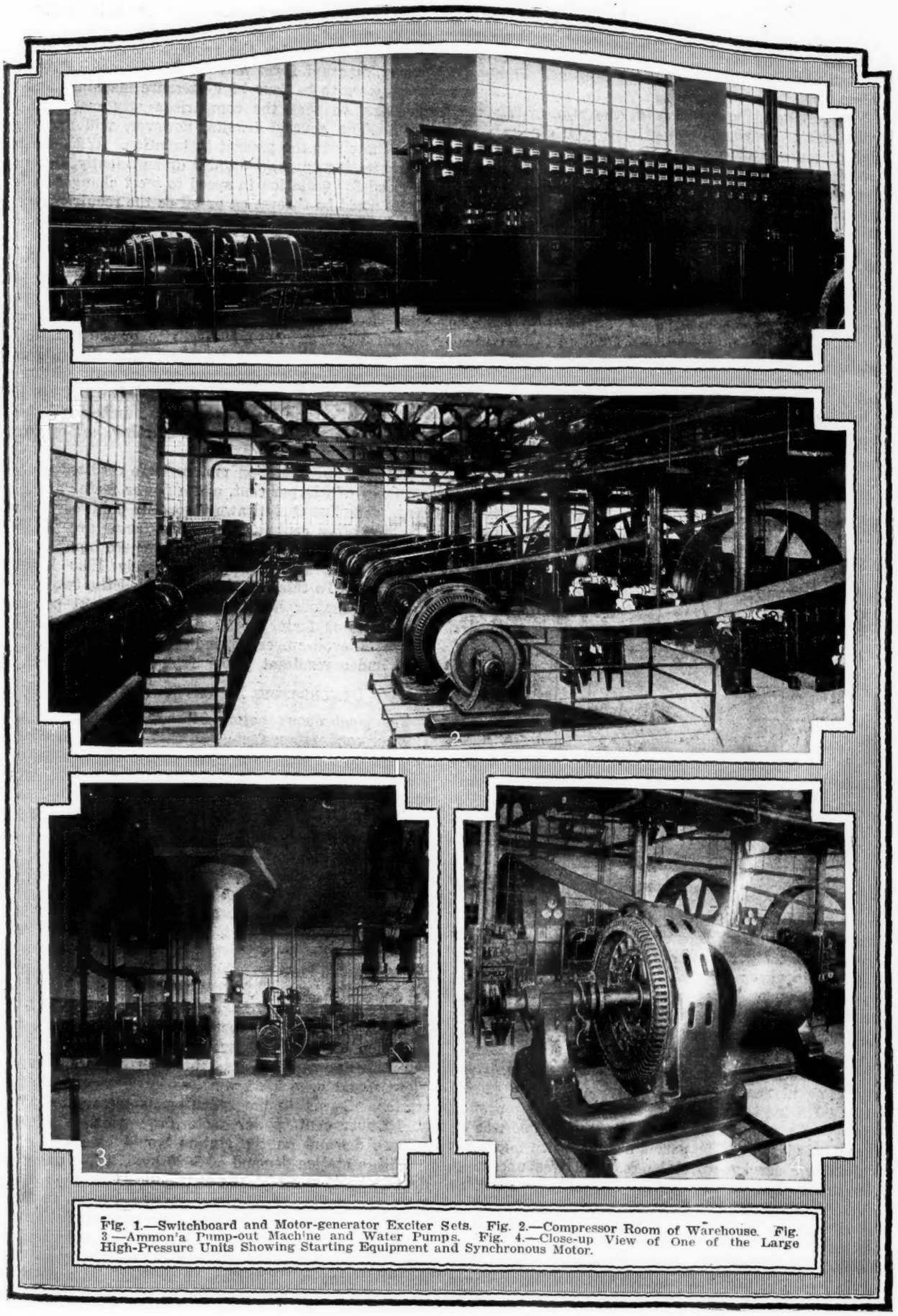


Fig. 1.—Switchboard and Motor-generator Exciter Sets. Fig. 2.—Compressor Room of Warehouse. Fig. 3.—Ammonia Pump-out Machine and Water Pumps. Fig. 4.—Close-up View of One of the Large High-Pressure Units Showing Starting Equipment and Synchronous Motor.

to the first layer by hickory dowel pins. The insulation is heavier than usual and the construction thoroughly good all the way through. It is evident that the Government has a substantial, convenient and highly efficient cold-storage warehouse.

The refrigerating plant is at the rear of the two-story wing previously mentioned. Originally, four high-pressure machines were specified, but owing to the reduction in service that would be needed on account of the cessation of the war, the fourth machine was omitted. The plant now contains three compressor units and two boosters having an aggregate capacity of 1005 tons of refrigeration. The compressors are of the horizontal, twin, double-acting type, with cylinders 17 x 36 in. Between the two compressors comprising the unit is a 15-ton flywheel, 18 ft. diameter and 43-in. face, serving as a belt pulley. The boosters are also of the twin type, with cylinders 30 x 42 in., having a displacement of 34.05 cu.ft., or 68.10 cu.ft. for the unit,

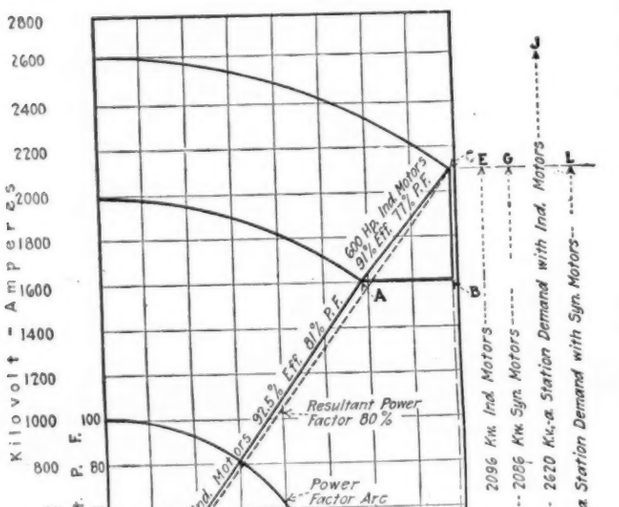

Kilovolt - Amperes
Per Cent. P. F.
600 Hp. Ind. Motors 91% Eff. 77% P.F.
2000 Hp. Ind. Motors 92.5% Eff. 81% P.F.
Resultant Power Factor 80%
Power Factor Arc
2096 Kw. Ind. Motors
2086 Kw. Syn. Motors
2620 Kv.-a. Station Demand with Ind. Motors
2086 Kv.-a. Station Demand with Syn. Motors
1565 Wattless Kv.-a. with Ind. Motors

FIG. 5. VECTOR DIAGRAM COMPARISON OF INDUCTION AND SYNCHRONOUS MOTOR DRIVE.

per revolution. Each booster unit is served by a 12-ton flywheel 18 ft. in diameter and 32-in. face.

Ammonia vapor from the house comes to the boosters at a pressure close to atmospheric, is delivered to the high-pressure machines at about 20 lb. and discharged to the condenser at the pressure required by the service (usually 150 to 175 pounds).

In choosing between steam and electric drive there were several features favoring the adoption of the latter. During the war it was difficult to obtain prompt delivery of steam-generating equipment. Time was an important element. The period during which maximum cold-storage service would be required was uncertain. The steam plant of the Central District was available to supply steam to the 7100 sq.ft. of direct radiation installed to heat the compressor room, offices, etc. Current at a low rate was available from the Produce Terminals Corporation in the U. S. yards near-by, and service could be installed readily. Electric service was the decision, and the next step was to choose between induction and synchronous motors for driving the compressors.

In this connection the relative comparison made in vector diagram form may be of interest. Originally, there were to be four high-pressure machines and two boosters, so that the comparison was made on this basis. The general results, however, will apply proportionately to the present installation. With the total refrigerating capacity divided up sufficiently, there was no need for variation in speed to meet changes in load. Units could be thrown on or off as the requirements demanded, and particularly in work of this character, as the variations easily could be foreseen.

For the high-pressure machines motors of 500-hp. capacity were required and 300-hp. motors for the boosters. These ratings are based on a 30-deg. temperature rise. The motors will carry a continuous overload of 25 per cent. at a 50-deg. rise, or 650 and 375 hp., respectively. Fig. 5 shows the vector diagram comparison of the kilovolt-ampere and kilowatt station demands when using four 500-hp. and two 300-hp. slip-ring induction motors, or the same number and size of synchronous motors of the self-starting, self-synchronizing type.

The 500-hp. induction motors were credited with an efficiency of 92½ per cent. and a power factor of 81 per cent. The line *O A*, drawn through a point corresponding to 81 per cent. on the power-factor arc and to a length determined by the kilovolt-ampere input to these four motors, indicates approximately 1980 kilovolt-amperes. To this load is to be added the two 300-hp. induction motors having an efficiency of 91 per cent. and a power factor of 77 per cent., giving final resultant kilovolt-amperage, indicated by the line *O C*, of 2620 and a resultant power factor of 80 per cent.

Synchronous Motors Were Selected

The synchronous motors will operate continuously at 100 per cent. power-factor, so that the kilovolt-ampere demand on the station is equal to the kilowatt demand. The latter may be figured readily from the efficiencies of the motors, the 500-hp. motors having an efficiency of 94 per cent. and the 300-hp. motors an efficiency of 93.6 per cent.

When using induction motors the kilovolt-ampere demand on the station is represented by the line *O C* in the diagram, which is equal to th line *J K*, or 2620 kv.-a. The kilovolt-ampere demand when using synchronous motors is equal to the line *L M*, or 2086 kv.-a. Considering the power factor in each case, the kilowatt demand would have been 2096 and 2086 kw. respectively, giving a difference of 10 kw. per hour in favor of the synchronous motors. Figured at 1c. per kw.-hr., this means a saving of 10c. per hour in actual energy consumption by using the synchronous motors. In addition the line *O D* shows that with induction motors there would be a 1565 wattless kv.-a. demand on the station. Owing to the synchronous motors operating at 100 per cent. power factor, the wattless kilovolt-ampere demand on the station would be zero.

With a station demand of 2620 kv.-a. when using induction motors and 2086 kv-a. with synchronous motors, there is a saving of 534 kv.-a station demand in favor of the latter. In other words, the central station capacity required by the induction motors would be 25.6 per cent. greater than with the same capacity in synchronous motors. To offset this advantage somewhat, the initial cost of the synchronous motors is greater.

For the present installation synchronous motors were selected of the size indicated previously. The operation has been entirely satisfactory, and by using the bypass on the compressors, there has been no difficulty in starting. At this period the characteristics of the synchronous motor are those of the induction motor, so that the operations are practically the same as with a motor of the latter type.

Three-phase 60-cycle current at 2200 volts, or line voltage, is taken by the motors. The speed of the motors is 360 r.p.m. and of the compressors 70 r.p.m. Connection between the two machines is effected by a to motors. Each tank is provided with a motor-operated ice crane, and there are suitable can dumps, thawing tubs and can fillers. Raw water from the city mains is frozen. An 8-in. line from the service tunnel is capable of delivering 250,000 gal. per day, this quantity being adequate to meet the needs of the refrigerating and ice-making plants and of the main building. For the clear ice, agitation is effected by compressed air supplied by a motor-driven compressor in the engine room.

In connection with the ice plant there is storage capacity of 5000 tons. The storage rooms extend

PRINCIPAL EQUIPMENT OF GOVERNMENT COLD-STORAGE WAREHOUSE

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Compressors	Twin double-acting	17x36-in	Refrigerating plant	Motor-driven, 70 r.p.m.	Ice and Cold Machine Co.
3	Motors	Synchronous	500-hp	Drive compressors	3-phase, 60-cycle, 2200-volt, 360 r.p.m	Electric Machinery Co.
2	Compressors	Twin, double-acting	30x42-in	Boosters	Motor-driven, 60 r.p.m.	Ice and Cold Machine Co.
2	Motors	Synchronous	300-hp	Drive boosters	3-phase, 60-cycle, 220-volt, 360 r.p.m	Electric Machinery Co.
2	Exciter sets	Syn.-motor-driven	50-kw	Excite syn. motors	75-hp. motor, 1200 r.p.m.	Electric Machinery Co.
1	Condenser	Atmospheric	90 stands, 21 pipes high.	Condenser ammonia vapor		Ice and Cold Machine Co.
1	Cooling tower	Natural ventilation	3,000-g.p.m.	Cool condenser water		Water Cooling Equipment Co.
3	Pumps	Single-stage cent.	1,000-g.p.m.	Circulate condenser water	Driven by Westinghouse 30-hp. ind. motor	Lea-Courtenay Co.
1	Pumpout mach.	2-cyl. vertical	9x9-in., 15 ton	Pump ammonia from system	Driven by G. E. 16-hp. ind. motor	Frick Co.
1	Ice plant	Raw-water can	150-ton	Ice for refrig. cars	Direct exp. coils in brine	Ice and Cold Machine Co.

Union Insulating Co., cork; 2 Curtis motor-operated ice cranes; Ball can dumps; Ball thawing tubs; Burns can fillers.

three-ply 42-in. leather belt on 35-ft. centers. The motor speed of the boosters is the same and the compressor speed 60 r.p.m. The driving belt is 30 in. wide and 36 ft. between centers.

Excitation is effected by two synchronous motor-generator sets consisting of a 75-hp. motor and a 50-kw. 125-volt direct-current generator. Either set will supply sufficient excitation current for the five large motors in the station and for its own driving motor. Other motors of the station for driving the elevators, ammonia pump-out machine and condenser circulating pumps are of the 220-volt induction type. Lighting is effected by three-wire 110-220-volt single-phase distribution.

On the roof over the central portion of the compressor room the ammonia condenser is housed in louver construction. It is of the atmospheric, continuous-flow, flooded type consisting of 90 stands 21 pipes high. Water for cooling comes from the cooling tower located over the ice plant and at a higher elevation. It is of wood and steel construction, with natural ventilation, and has a capacity of 3000 gal. per min. From the condenser pan the cooling water enters the suction of motor-driven single-stage centrifugal pumps located on the compressor-room floor and is elevated to the top of the cooling tower. The head against which the pumps operate, however, is the difference between the two water columns plus the friction in the piping. There are three pumps, each of 1000 gal. per min. capacity and driven by a 30-hp. induction motor. Two pumps handle the service, leaving one as a spare.

One Hundred and Fifty Ton Ice Plant

To furnish ice for refrigerator cars and other purposes, a 150-ton plant was provided. It contains the complete equipment for two tanks, one for the manufacture of clear ice and the other for making opaque ice. Each tank is 68 ft. long, 36 ft. wide and 60 in. deep, and the two tanks contain a total of 1820 cans of the 400-lb. size. A temperature of approximately 15 deg. F. is maintained in the tanks by direct-expansion coils immersed in brine. Circulation is effected by two propellers per tank of the vertical type direct-connected through two stories, occupying space between the compressor room and the main building. The plan area of the reserve storage is 6045 sq.ft. and the volume 175,305 cu.ft. Immediately above is the daily ice-storage room having an area of 4595 sq.ft. and a content of 59,103 cu.ft. The ice-making room is at the same level and adjoining the daily storage, while the reserve storage extends downward to the main floor to give convenient access for icing the cars.

Plans were prepared for the Central Manufacturing District, contractor, by S. Scott Joy, architect, who retained Henschien & MacLaren, of Chicago, as consulting engineers. The Government was represented during the construction by Major S. L. Nelson, constructing quartermaster; S. F. Forbes, supervising engineer, and Gardner and Lindberg, supervising architects. The plant has been leased by the Government to the United States Cold Storage Co., with C. D. Allman, general superintendent, and F. J. Roose, chief engineer, in charge of operations.

A Practical Method of Checking Watt-Hour Meter Connections

By E. A. Fischer

Two-wire watt-hour meters, either direct current or single-phase alternating current, can be connected in but two ways—either to run forward or backward. Sometimes the direction of rotation is unknown and the proper rotation must be determined in order to have the correct registration. This may be easily determined by disconnecting the register and by turning it and noting the direction of rotation of the gear engaging the shaft of the rotating element; when the pointers are traveling in the right direction, the rotating element must run in such direction.

In computing the size of feed pipe for a boiler provision should be made for a capacity of twice that required at its normal rating, and proportion the pipe for a velocity of about 100 feet per minute for sizes ranging from 1 to 2-inches.

The Relation of Time of Ignition to the Economy of the Gasoline Engine

By J. P. CALDERWOOD* and A. J. MACK†

PRACTICE has more or less standardized the time of ignition in the operation of stationary gasoline engines, yet there may be certain advantages gained by changing the point of ignition beyond that fixed by precedent. Whether or not the economy would be improved by increasing the spark angle is a question that could logically be asked, but the direct answer, if reasonably accurate, is difficult because of the many variables that enter.

Based upon the theoretical cycle, varying the time of ignition beyond that of dead-center plays little or no part in increasing the economy of the engine. The Otto cycle, as the reader will recall, is made up essentially of two constant volume and two adiabatic curves. The cycle in its theoretical operation requires what might be termed a perfectly combustible gas—one that, when ignited, burns immediately, producing the constant volume expansion or explosion curve of the Otto cycle. The time of the spark in such a case is at dead-center, and as soon as ignition takes place the function of the spark is complete. Advancing the spark would tend to retard the engine, while retarding the spark to a point where ignition occurred after dead-center had been reached would in like manner cause a loss of power and economy. Consequently, theory indicates that advancing or retarding the spark would produce a decrease in economy.

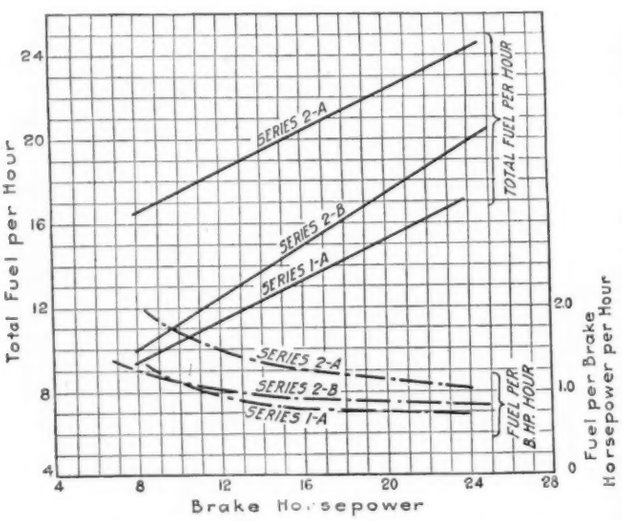


FIG. 1. RESULTS OF TESTS TO DETERMINE THE EFFECT OF SPARK ADVANCE UPON THE ECONOMY OF A THROTTLE-GOVERNED GASOLINE ENGINE

However, this theory may be in error when applied to the practical cycle. The gasoline engine does not utilize a perfectly combustible gas. As a result an appreciable period of time is required for the explosion. Consequently, to approach the constant volume explosion curve of the theoretical cycle, the time of ignition must be advanced beyond that of dead-center.

Since ignition of the charge before reaching dead-center is necessary because of the slower-burning or explosion properties of gasoline vapors, it may be reasoned that when once adjusted and the engine operated at normal speed no alteration in the spark would be necessary. This reasoning is sound, and if it were true would simplify gasoline-engine operation. However, the rate of flame propagation of gasoline vapor does not remain constant with the result that the time of ignition must be changed to suit. It is this fact that often complicates any theoretical discussion of the effects that may be expected from altering the time of ignition.

RESULTS OBTAINED FROM THE TESTS

Run Number	Revolutions per Minute	Brake Horsepower	Pounds of Fuel Used per Hour: Total	Pounds of Fuel Used per Hour: Per B. Hp.	Per Cent. Thermal Efficiency Based on B. Hp.
		Series 1-A			
9	265.8	23.97	17.0	0.710	17.7
10	284.2	19.25	15.0	0.787	16.0
7	277 0	19.20	14.5	0.755	16.8
11	287.7	13.00	12.5	0.962	13.1
4	282.1	8.34	9.2	1.110	11.3
		Series 2-A			
1	266.5	24.70	24.5	0.99	12.7
2	279.0	19.40	22.5	1.16	10.9
3	285.0	14.75	18.5	1.25	10.1
		Series 2-B			
61	272.3	25.14	20 5	0.817	15.5
62	283.0	19.58	17.0	0.871	14.5
63	286.0	13.33	12.3	0.924	13.7
64	287.6	6.64	9.2	1.38	9.1

Just what conditions alter the flame-propagating qualities of gasoline vapor is perhaps not fully understood, but tests seem to indicate that it is a function of the temperature and quality of the mixture. With constant fuel mixture, the flame propagation is increased by increasing the pressure at the end of the compression stroke, by increasing the temperature of the jacket water, by increasing the temperature of the inlet mixture, and by decreasing the speed of the engine; while with variable fuel mixtures high flame propagation is especially pronounced with leaner mixtures, gradually decreasing as the mixture becomes richer. These facts introduce so many variables in the operation of the gasoline engine that to advance a reasonably accurate opinion as to the effect of time of ignition would be difficult.

Tests by the Engineering Experiment Station of the Kansas State Agricultural College

In order to study the effect of spark advance upon the economy of the gasoline engine, a rather extensive series of tests has been conducted by the Engineering Experiment Station of the Kansas State Agricultural College. These tests were conducted upon a 25-hp., four-stroke-cycle horizontal gas engine. The engine was equipped with a throttling governor and the ignition accomplished by means of a wipe spark.

During the test all conditions, such as temperature of the jacket water and speed of the machine, which

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would change the flame propagation of the fuel, were maintained as nearly constant as possible. In each series of tests the only variable was that of load, and great care was exercised to secure identical fuel for all tests.

The investigation included many tests and a great quantity of data was secured, but for the purpose of this discussion may be reduced to three series.

Series 1-A was conducted to determine the fuel economy of the engine when operating at various loads

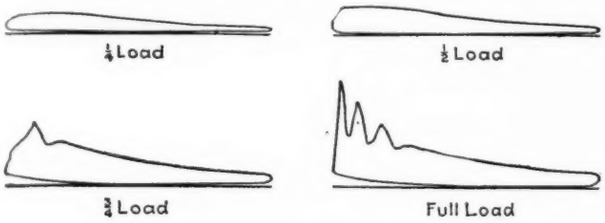


FIG. 2. INDICATOR DIAGRAMS FROM THROTTLE-GOVERNED GASOLINE ENGINE, SHOWING DEVIATION FROM THE CONSTANT VOLUME EXPLOSION AT VARIOUS LOADS

with the carburetor so adjusted as to give an economical mixture and the maximum load with a constant spark advance of about 30 deg. No alterations in the setting of the carburetor were made during the test, the governor being entirely relied upon for speed regulation.

Series 2-*A* was conducted under the same conditions as Series 1-*A*, with the exception that the carburetor was so adjusted as to produce a rich fuel mixture. This series is directly comparable with Series 1-*A* and shows the effect of poor carburetor adjustment upon the economy.

Series 2-*B* was conducted under the same conditions as Series 2-*A*, but with the spark advanced to an angle of 42 deg. This setting of the spark resulted in the maximum load for that adjustment of the carburetor. This series is comparable with Series 1-*A* in that it shows the relation between the economy, power and spark advance for two settings of the carburetor.

The principal results obtained from these tests are given in the table and are graphically represented in Fig. 1.

Results of Tests Conform With Those Predicted

The results of these tests conform with those that were predicted from theory. Spark advance above that nominally carried produces no increase in economy of the engine. For each condition of fuel mixture, temperature of jacket water and other factors that influence the flame-propagating qualities of the gasoline vapors a certain definite time of ignition is necessary to produce the desired explosion. Ignition above this point produces preignition or pound, while ignition below produces a gradual decrease in the speed of the engine.

This investigation has pointed out several rather important functions of the spark as follows:

1. With other conditions constant the economical spark advance to be carried depends upon the fuel mixture. With richer mixtures higher spark advance may be utilized.

2. With a richer mixture and higher spark advance the maximum delivered horsepower will be greater than can be secured with leaner mixtures and smaller spark advance. This statement does not contemplate, however, the use of fuel mixtures so rich that incomplete combustion may result. The economy will probably decrease as the richness of the fuel mixture increases.

3. The fuel economy of the gasoline engine depends very largely upon the carburetor setting, but the poorer economy due to improper carburetor adjustment can be largely corrected by altering the position of the spark. Thus if a carburetor produces too rich a mixture, advancing the spark until the combustion or explosion curve is vertical will result in practically the same economy as will be obtained with a proper carburetor adjustment and smaller spark advance.

4. The economy of the throttle-governed engine can be improved by the use of a variable spark advance, especially upon those engines that are operated under variable loads. How this theory may be applied to the throttle-governed gasoline engine can best be explained by considering the action of the governor.

With the throttle governor the proportion of the air to gas mixture remains theoretically constant, while the quantity of the mixture admitted per cycle is varied to suit the power demand. This is accomplished by throttling the fuel charge during the entire suction stroke, thus reducing the pressure of the entering gas and regulating the amount of the charge admitted. With this type of governor the reduction in the amount of the mixture results in the lowering of the compression curve at all loads except at maximum or full load, when the governing valve would be entirely open.

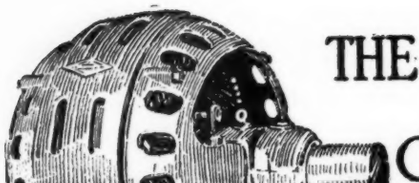
Lowering Compression Curve Lowers Pressure and Temperature of Fuel Mixture.

The lowering of the compression curve lowers the pressure and temperature of the fuel mixture at the firing period. With constant spark advance for all loads, which is usually the case in stationary gasoline-engine practice, the flame propagation of the mixture varies as the delivered power diminishes, and as a result, through no fault of the governor, the degree of economy needlessly decreases at the lighter loads. Variations in the flame propagation for the various loads are noticeable from the indicator cards shown in Fig. 2. The effect upon the economy is slight between full and three-quarter loads, but increases rapidly beyond that point.

To take advantage of this fact, the degree of spark advance would have to be greater than is now possible with most engines. About the maximum range in spark control is 30 deg., and this limits the advance to that point since zero spark advance is advisable in starting. If the best economy at all loads of throttle-governed engines is to be secured by altering the time of ignition, the maximum throw of the spark should be greater than 30 deg. A zero spark angle should be provided for starting, about a 30-deg. angle for full load, while a 50- or 60-deg. angle should be provided for lighter loads.

It is comparatively easy for the operator to judge when the spark conditions are such as to produce the best economy. The spark should be advanced until a slight pound due to the rapid burning of the fuel charge is heard, then the spark should be slightly retarded until this pound just disappears.

The regulation of the spark could be made automatic by connection to the governor. At the lighter loads the speed of the engine and consequently the governor is perceptibly increased, and this change in speed could be utilized in adjusting the spark. However, few of the stationary gasoline engines are so equipped.



THE FLOW OF WATTLESS CURRENT EXPLAINED

By

*Will Brown**

Just what a synchronous motor does when correcting power factor is made plain by a comparison with the action of water in a pipe, where pressure corresponds to voltage and flow of water to amperes.

NO SOONER do we start to discuss synchronous motors than we raise the bogy of power factor and the flow of wattless current. To be sure, the synchronous motor is a mechanical machine to do work—quite similar in many ways to an induction motor—but it has one great electrical advantage that no induction motor can ever possess, namely, its power factor can be controlled.

Power factor of alternating-current circuits has always been a difficult thing for those with a limited technical training to understand. It is easy to dismiss it with an offhand comparison or to give a technical definition, but the trouble is, these do not really explain. Almost everyone can understand the action of water in a pipe, where pressure corresponds to voltage and flow of water (gallons per minute) corresponds to current (amperes).

Let us examine the diagrams, Figs. 1 to 8, which represent sectional views of a water pipe and piston pump. Here *P* is a piston which travels forward and back in pipe *M*, between the points *L* and *K*, representing the starting point and end of each stroke; *A* is a valve in the piston, *A'* is a valve leading to the discharge pipe *S*, *C* is an air chamber, and *J* is the level of the water in the air chamber when the piston is not exerting pressure. There is a constant supply of water

FIG. 1

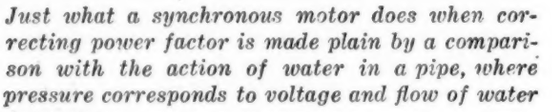


FIG. 2

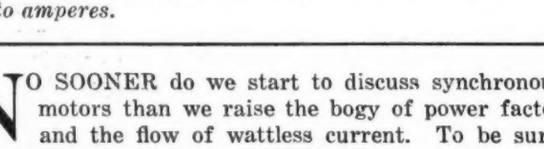


FIG. 3

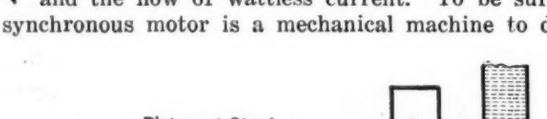


FIG. 4

FIGS. 1 TO 4. SHOW PISTON AND FLOW OF WATER ON FORWARD STROKE

FIG. 5

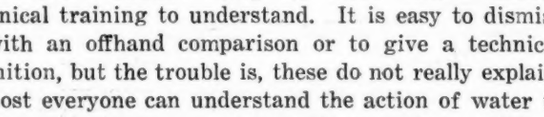


FIG. 6

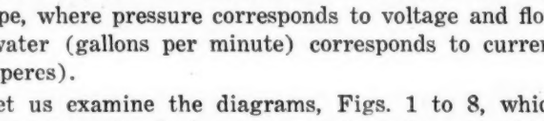


FIG. 7

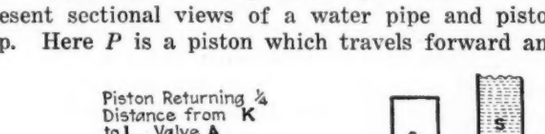


FIG. 8

FIGS. 5 TO 8. SHOW PISTON AND FLOW OF WATER ON RETURN STROKE

*Engineer with the Electric Machinery Company.

in the pipe M which maintains a normal level at J. The piston P travels forward and back between points L and K. Valve A closes under pressure when the piston is moving toward K. Valve A' opens when the pressure from the left becomes greater than the pressure from the right.

There is a constant pressure in the discharge of pipe S due to the head. When piston P travels forward from L to K, it forces the water ahead of it. Water is not compressible and must find a place to go. The arrows indicate the flow of water, solid arrows showing effective flow and wavy arrows reactive flow. Since there is a pressure in the discharge pipe S greater than the air pressure in C, valve A' will stay closed and the water will be forced up into chamber C, until the pressure of the air thus compressed equals the pressure of S. Then valve A' will open, and the rest of the water will be forced out through discharge pipe S.

When the piston stops at K (end of stroke), there is no longer any force driving the water forward, ignoring the momentum. Pressure in S then closes valve A', and pressure in C helps to force the piston backward on its return stroke. Valve A remains closed on the return stroke until the water in C drops to its former level, when valve A opens and allows the piston to continue back to L while a fresh supply of water enters the pump.

Let us assume that one-fourth of the volume of water in the pump (from L to K) is forced up in chamber C at each forward stroke and returns again into the pump at each backward stroke. The pump therefore delivers only three-fourths of its capacity to the discharge pipe S. In other words, the pump is running at 75 per cent. power factor. No actual power is consumed by forcing the water into chamber C for the reason that an equal amount of power is returned to the piston on the return stroke.

Pressure in the pump corresponds to voltage in an electric circuit; flow of water through the pipe corresponds to current. It is plain to be seen that no water begins to flow in the discharge pipe S until the pressure on valve A' has increased from zero to a point equal to the pressure of the head. In other words, the flow lags behind the pressure just as the current lags behind the voltage in an inductive alternating-current circuit.

The volume of water moved, at the pressure maintained, while the piston is traveling from L to K, corresponds to apparent power (kv.-a). The volume of water forced at the pressure maintained through the discharge pipe S corresponds to real power (kw.). The water that flows up and down in chamber C corresponds to reactive, or wattless, current. If chamber C is closed, there will be no reactive current and the full capacity of the pump will be delivered at each stroke; or, in other words, the pump will operate at 100 per cent. power factor.

While the foregoing is a good hydraulic explanation of lagging power factor, where current lags behind voltage, there is no exact analogy for leading power factor, where current leads the voltage. But suppose we imagine a gas that has a quality exactly opposite to compressibility of air; that is, when subjected to pressure, such a gas would increase in volume instead of decrease.

Let us say that chamber D, Fig. 9, contains such a gas (shaded portion at bottom). Now when piston P makes a stroke, the action in chamber D is exactly the reverse of what takes place in chamber C. As the piston pressure builds up, water flows into chamber C, but flows out of chamber D because this gas expands under pressure. As the pressure decreases, water flows out of chamber C and flows into chamber D. Thus the actions of these two chambers tend to neutralize each other.

If the size of the chambers and the quantity of gas in each are equal and the quality of compressibility in gas C is balanced by the opposite quality of gas D, then the two chambers balance each other and the pump operates at its full capacity, or 100 per cent. power factor. The excess water in the two chambers C and D does not take up the capacity of the pump, as it merely flows back and forth between the chambers.

Comparing this to an electrical circuit, the action that takes place in C could be called inductance; that

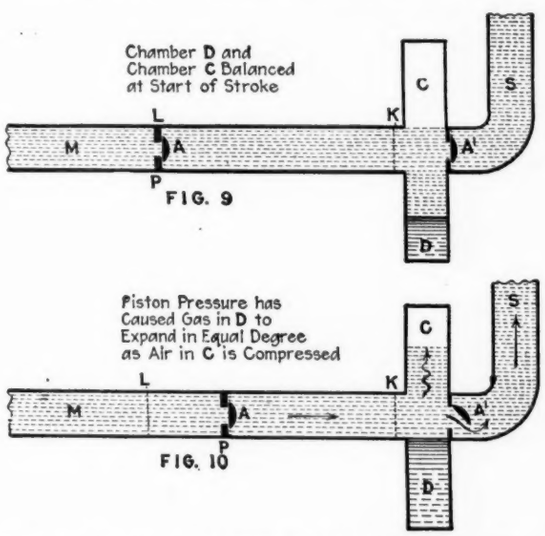


FIG. 9

FIG. 10

FIGS. 9 AND 10. CHAMBER D ADDED TO OVERCOME EFFECTS OF CHAMBER C, FIGS. 1 TO 8

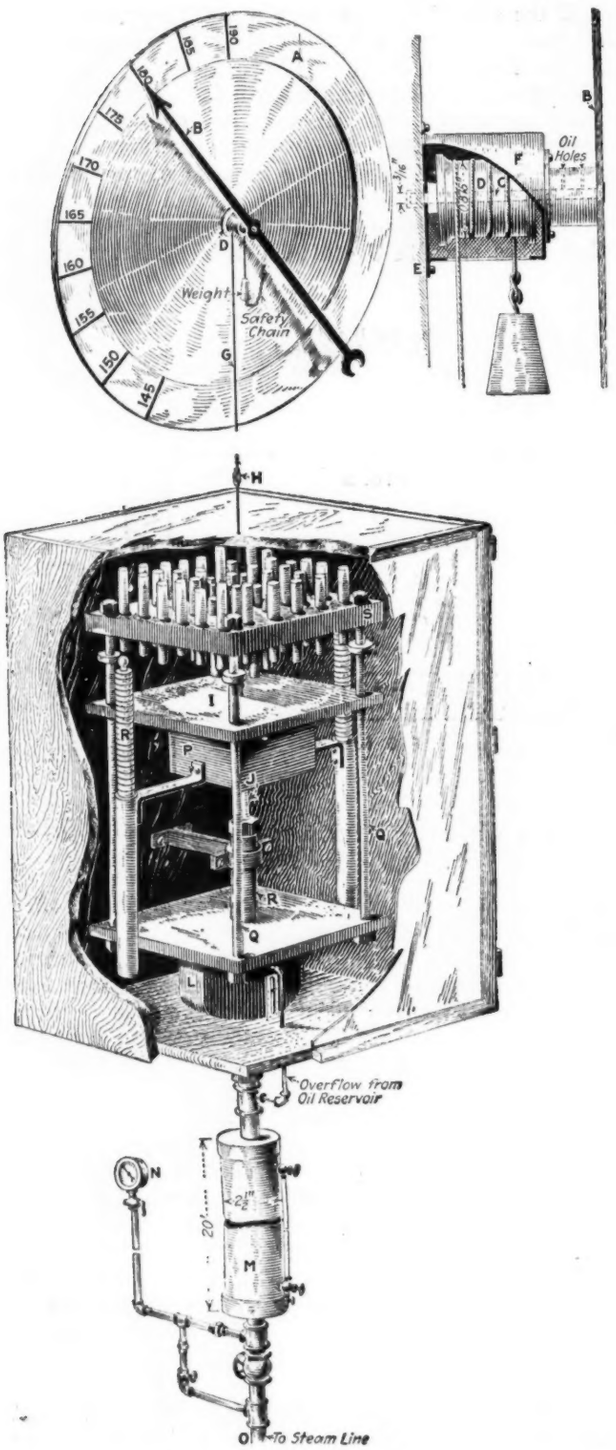
of D, capacity. Every induction motor causes an effect similar to C. The pump corresponds to the generator. The mechanical power that drives the piston corresponds to the prime mover. The water that flows back and forth between chamber C and chamber D corresponds to reactive current flowing back and forth between the rotors of induction motors and synchronous motors.

When a pump (alternating-current generator) is operating at low power factor, the amount of water forced ahead of the piston at each forward stroke (volt-amperes) is just as large as if the power factor was 100 per cent. But the amount of water actually forced into the discharge pipe (watts to perform useful work) is less. And the power required to drive the piston back and forth (horsepower of prime mover) is not as much at low power factor because a part of the power used on the forward stroke is returned to the piston during the return stroke.

Now perhaps a mind picture is obtained of what happens when a synchronous motor (at leading power factor) is put on a circuit of lagging power factor. Useless current which has been loading up the generators is removed, and it is possible to get much more capacity out of the same generators, distribution system, etc. In fact, it is possible to get more work out of all apparatus on the system. The cost of producing and delivering electric power is also reduced.

Home-Made Master Steam Gage

An interesting auxiliary apparatus found in the Pratt Street Station of the United Electric and Railway Co., Baltimore, Md., is a home-made master steam gage that can be seen from all parts of the engine room. It was built by the chief engineer, Malcolm Wright.



DETAILS OF THE MASTER STEAM GAGE CONSTRUCTION

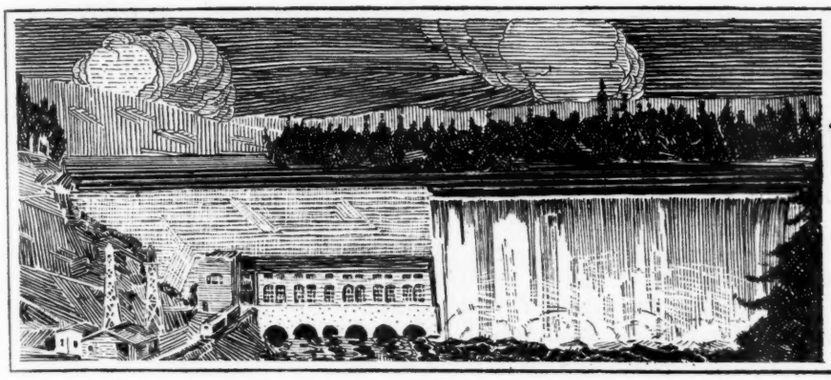
The dial of the gage *A* is made of wood and is 6 ft. in diameter with a rim 6 in. wide. As 180 lb. steam pressure is carried, the dial is numbered from 145 to 190 lb. An indicating pointer *B*, about 60 in. long, is secured to a shaft *C* which carries a flange spool *D* 0.875 in. in diameter at the winding section and $\frac{7}{8}$ in. long. This roller shaft fits in a bearing in the rear support *E*, and the other end fits in a bearing that is secured to the casing *F*. A cord *G* makes three turns around the spool *D*, and at one end a weight 8 in. long and $1\frac{1}{4}$ in. in diameter is attached. To the bottom of the weight one end of a chain is fastened, and the other end is attached to the gage mounting. This chain is a safety precaution in case the cord should break. The other end of the cord *G* is attached to a turnbuckle *H*. This is made of a piece of $\frac{1}{8}$-in. pipe threaded at both ends for screweye-rods. The lower end of the turnbuckle carries a cord that is secured to the crosshead *I* of a weighted piston *J* which moves up and down in a cylinder *K*, the movement corresponding to the pressure exerted on the bottom of the piston *J* by oil in the oil reservoir *L*, which is under boiler pressure. The reservoir *L* is piped to an oil reservoir *M* $2\frac{1}{2}$ in. in diameter and 20 in. long. Both oil reservoirs are fitted with gage-glasses. At the bottom of the reservoir *M* suitable connections are made for the purpose of draining water and for attaching a gage *N* to be used as a check on the master gage. The pipe *O* is connected to the main steam header.

As stated, the indicating pointer on the gage is actuated by the movement of the weight plunger. The arrangement of the weights is the most important part of the apparatus. The main weight *P*, of lead, is carried directly by the plunger *J* and supports the crosshead *I*, which slides on the four uprights *Q*. On two sides of the weight *P* is bolted an angle iron that carries a number of adjusting weights *R*. With the weights *P* and *R* adjusted to balance a steam pressure of 162 lb., the dial pointer is also at the 162-lb. mark.

Across the top of the four guide posts *Q* is a perforated plate *S* in which 38 weights, each weighing 1 lb., are so placed that no two of them project below the plate *S* the same distance. These weights are hung on pins to give them the desired position. Thus, as the plunger is forced up by increased steam pressure, a 1-lb. weight is added to the plunger load for each pound increase in pressure, so that at a pressure of 180 lb. on the boiler the plunger will be carrying not only the weights *P* and *R*, but the thirty-eight 1-lb. weights as well. The gage pointer will then indicate 180 pounds.

As the pressure decreases the weights force the plunger *J* down until one of the 1-lb. weights rests on its pin which suspends it from the weight plate. If the steam pressure still decreases another pound, the weights will force the plunger *J* down still farther until another of the 1-lb. weights rests upon its supporting pin. Thus the variation in the boiler steam pressure lifts or seats one or more of the 1-lb. weights for pressures between 142 and 180 pounds.

One company alone, during 1918, built over 500 synchronous motors, aggregating 300,000 hp. capacity. This is exclusive of synchronous condensers. Of this number over 200 motors, with an aggregate capacity of 90,000 hp., were built for air-compressor drive alone. When it is considered that this represents the output of one company only, and that there are a half-dozen or more large companies building this type of machine, it will at once become apparent what an important factor the synchronous motor is becoming.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"TO GET down to business," said Jimmy to Pop, "I'll bet you can't tell me the great differences between a Pelton wheel and a Francis turbine."

"Tryin' to heckle me, hey?"

"I call," said Jimmy. "What have you got?"

"Well, to begin at the beginnin', a Francis turbine always works 'drowned,' or in the water in some way or other, while a Pelton wheel always must work outa the water. It's true that the hull bloomin' thing will be wet, but it can't work efficiently when it's in the water."

"And next," interrupted Jimmy, for fear that Pop would get ahead of him, "they don't have any draft tubes."

"They uster make them with draft tubes," put in Pop, "but that means a float riggin' to keep the water at a certain level in the draft tube, so it will never git up to the wheel. Now with the heads the Pelton wheel is gen'ly used with, a few feet loss in head on account of havin' a free tailrace is of less consequence than all the time fussin' an' foolin' with a float riggin' that never was foolproof."

"And they don't take water all around the wheel like a turbine does."

"No, Jimmy; but it's quite common to see Pelton wheels with two or more streams a-playin' on them."

"And," continued Jimmy, "while a turbine may work with its shaft either horizontal or vertical, the Pelton wheel works best with its shaft horizontal."

"Yes, son," chimed in Pop, keeping right on Jimmy's heels, "they has them vertical on some whoppin' big jobs, but it's gen'ly admitted that what you say is so."

"And while the turbine is regarded as being most efficient at low heads, the Pelton wheel is most efficient at high heads, where a small jet or stream will do the work."

"Yes, that's true. The Francis turbine has been used up to 750 ft. head, but conservative practice puts the limit at about 500 ft.; the Pelton wheel, on the contrary, has been used on heads as low as 20 ft., but here agin, conservative practice says 50 ft. is low enough. But they's other considerations that sometimes makes the use of the Pelton wheel advisable under low and medium heads. Suppose a man wants a small amount of power under a medium head. In such a case the Pelton wheel would be the cheaper layout and much simpler, too. Now supposin' a feller has about 200 ft. head an' wants a fair-sized power at a moderate speed. The Francis turbine bein' essentially a high-speed machine, it would have to be made big so that they could git the speed down, or else drive through a lotta gearin', which is a bad proppysition an' to be avoided when you can. In such a case the Pelton wheel would have it on the turbine again.

"Now another frequent case. We'll say the water is bad, that it carries large quantities of silt or sand, or that it has acid in solution. In such a case the Francis turbine would not be thought of as competin' agin the Pelton wheel. The Francis turbine is quite a complicated machine agin the other, because it has so many machined joints that the water gits to. These joints, under bad conditions, would be so soon eaten out that the efficiency would be gone before you knowed it. Now with a Pelton wheel you'd take off the worn buckets and put on some new ones or take out the hull nozzle an' put in a new one in quick time. That's about the only parts that wear out on a Pelton wheel."

"But I thought you could take care of the sand by having the velocity in the forebay small enough so that it would settle, and that such things as branches and leaves can be taken out by a good trash rack?"

Sudden showers and freshets like they gits in tropical countries brings down sand an' leaves an' even young stones which would kill a turbine in a short time. Turbines ain't never been much of a success as stone crushers or pulp grinders. Another thing with the Pelton wheel, the discharge of the nozzle is free, so anything that can pass through the nozzle will be thrown on the buckets an' not hurt them."

"You've told us quite a few advantages of the Pelton wheel; now tell us some of the disadvantages."

"Well, one of 'em is that the Pelton wheel has a very low specific speed as compared with the Francis turbine. Francis turbines have been made with a specific speed of 150, which of course is for very low heads, not exceeding 30 ft., while the best you can do with a Pelton wheel is about 7 with one jet on the wheel, or about 10 with one wheel and two jets. Of course, if you put two jets on two wheels, you can put them on one shaft and so git about 14, an' you can see it's darn low comparin' it to the turbine. That's about the worst you can say about the Pelton wheel.

"They's jes' one more little thing I wants to say. The Pelton wheel maintains its efficiency over a very wide range of load. It's possible to design a wheel that will have over 80 per cent. efficiency all the way from about quarter load to maximum capacity. Now it takes some turbine to do that, and you'll find that as a rule the turbine manufacturers don't holler very loud about the efficiency of their turbines from half-load down."

"Pop, tell us how the power is figured on Pelton wheels."

"How would you think it was done? The principles ain't any different than I showed you for the

turbine. In the design it is common to assume the efficiency at 80 per cent. although the wheel will probably give more if well designed. Now, supposin' you wants 500 hp. under, say, 400 ft. head. Long ago in these talks I gave you some power constants to use in figgerin' the water quantity. Now the constant for 80 per cent. efficiency is 11. So 500 times 11 is 5500, which, divided by the head, or 400, gives 13.75 cu.ft. per second. Again, I showed you how to figger the spoutin' velocity as 8 times the square root of the head. The square root of 400 is 20; so the velocity is $8 \times 20 = 160$ ft. per second. Divide 13.75 by 160 an' you gits 0.086 sq.ft. nozzle area. To this we adds 2 per cent. for nozzle losses, makin' 0.0877 sq.ft. Multiply that by 144 and you git 12.629, the area in square inches; an' fin'ly, from a table of areas of circles, you sees that 12.62 sq.in. corresponds to a shade more than 4 in. in diameter. See? Kinda easy, ain't it?"

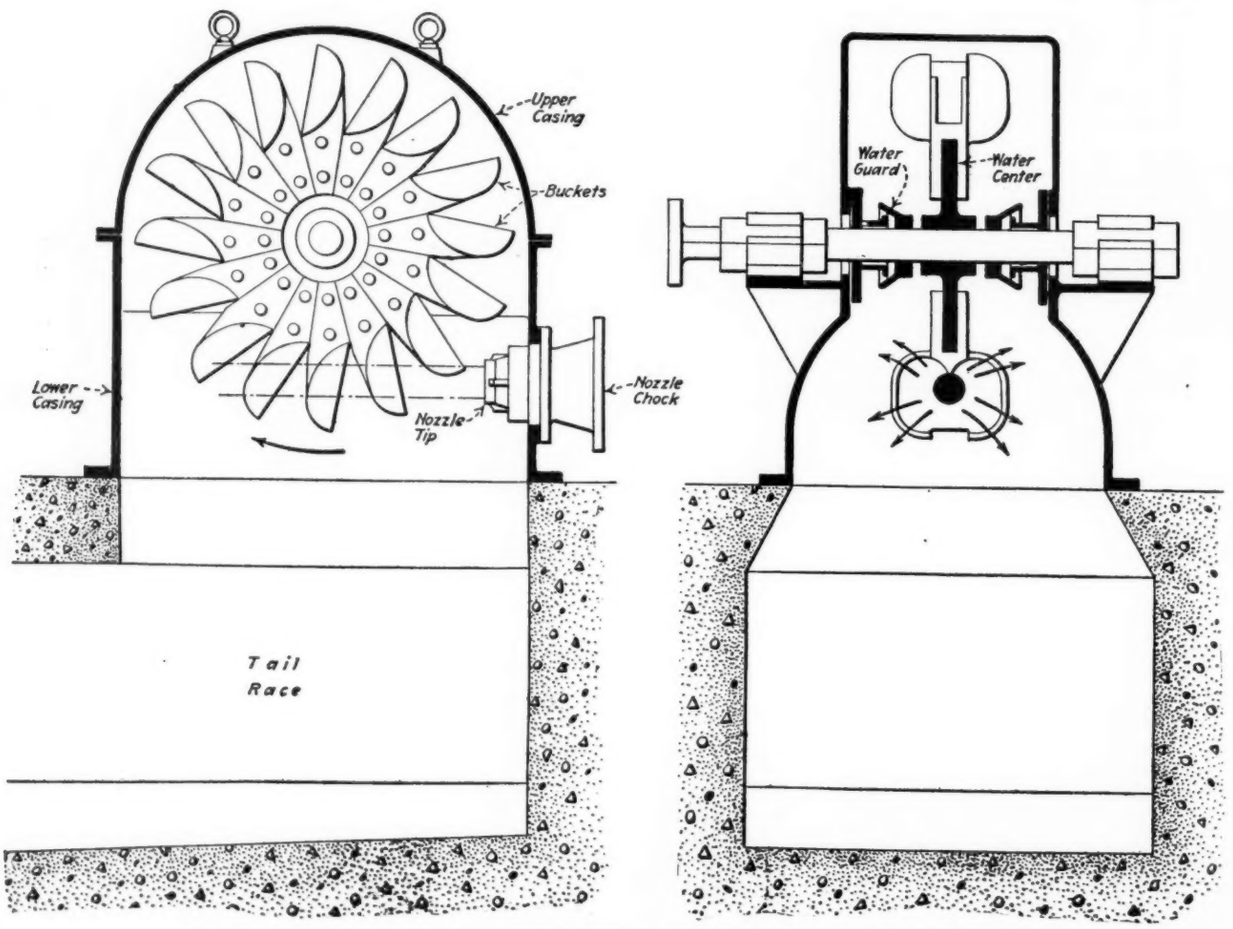
"Now Pop, how about the speed? We haven't said what speed we're going to have."

"With the Pelton wheel, like the Francis turbine, there is a limit to the speed in r.p.m. that we can have. Now, by experience it has been found that the diameter on the stream line, or Pelton circle, as some engineers calls it (refer to the illustration), should not be less than about 9 times the diameter of the jet. They has made 'em with as low as 6½ diameters, but the efficiency ain't good and there is serious difficulties in gittin' enough buckets on the wheel. So in our case, we'll say the diameter is 36 in. on the stream line, an' we gotta be satisfied with the speed we git by so doin', or else divide the area of the nozzle between two streams so we then can make the diameter of the wheel 9 times the diameter of the smaller stream. In such a case the wheel could be made 25.5 in. in diameter with a correspondin' higher speed. But in this example we will stick to the idee of usin' one stream.

"Now, the Pelton wheel has another queer thing about it. It can't run at as wide a range of speed as the turbine. As I showed you before, the turbine can run at anything between 60 and 95 per cent. of the spoutin' velocity. But with the Pelton wheel we is tied down rather close, usually about 46 per cent. of the spoutin' velocity on the stream line. This, Jimmy, is the speed at which the wheel gives the best efficiency, an' the r.p.m. is figgered darn quick by multiplyin' 850 by the square root of the head an then dividin' by the diameter in inches on the stream line to git the r.p.m. or by the r.p.m. to git the diameter in inches. So, 850 times 20, the square root of 400, is 17,000; divide that by 36 in. an' we gits 472 r.p.m., which can be called 475."

"I suppose the bigger the wheel the more power you get, because you have more leverage with a big wheel than a small one. Is that right?"

"No, it ain't!" snapped Pop. "I seed a number of textbocks that says it is an' they oughta know better. When you makes the wheel big, you increase the leverage, but you decrease the speed as fast as you increase the leverage; so we can say the diameter of the wheel



PELTON TYPE OF WHEEL, ILLUSTRATING THE STREAM LINE OR PELTON CYCLE

does not affect the power aside from secondary effects, as I says before about havin' the wheel so many times the jet diameter. Git me?"

"Yes, Pop, I get that. Now tell me if the number of buckets on the wheel affects its power."

"No, they don't affect the power as long as they is enough of them. They is supposed to catch every particle of pressure water outa the nozzle an' then turn it through an angle as near 180 deg. as possible."

"I heard the lecturer talking about 'ratio' to you while you had your right feet planted on Casey's footrail and your right elbows on his bar. Now, what does 'ratio' mean?"

"Ratio, as he used the word, means the ratio of the diameter on the stream line to the jet diameter."

"Oh, that's simple"

"Son, they is a relation between what we calls ratio and specific speed or type characteristic. Ratio times the specific speed is equal to a constant times the percentage of spoutin' velocity, the constant bein' 115.5. In other words, an' to take an example, we had a ratio of 9 in our previous example, an' 46 per cent. spoutin' velocity. Now multiply 115.5 by 0.46 an' we gits 53.1; divide 53.1 by 9 an' we gits the specific speed, 5.9. When the percentage of spoutin' velocity is 0.46, then you can divide 53.1 by the ratio to git the specific speed or divide the same number by the specific speed to git the ratio. I gives you a little table here:

Ratio.....	6	7	8	9	10	11	12	14	16	18	20
Specific Speed	8.85	7.59	6.65	5.90	5.31	4.83	4.43	3.80	3.32	2.95	2.66

Git the idee?"

"Hot Patch" Furnace Cement

Constructing new boiler furnaces, replacing furnace linings and patching burned-out furnaces is expensive work, as each job requires cutting the boiler out of service. If a cement is used that will not disintegrate under furnace conditions as quickly as fireclay, the labor and the expense for setting upkeep can then be reduced.

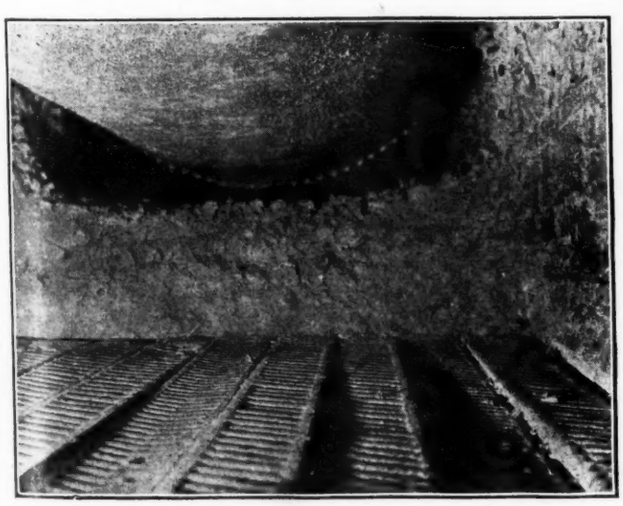


FIG. 1. FURNACE REPAIRED WITH "HOT PATCH" CEMENT

What is known as "Hot Patch" cement is made to give the furnace double life. It is a high-temperature resisting plastic compound that remains permanently adhesive at high temperatures. It is applied very thinly and upon drying becomes hard, adheres to the brick and forms a highly refractory wall. It is compounded so as to expand and contract closely with the brick. Thus there is practically equal expansion and contraction throughout the furnace brickwork.

Fig. 1 shows a furnace repaired with "Hot Patch" cement and Fig. 2 shows one repaired with fireclay. Both were under boilers in the same boiler house, and each had been in use and operating under the same

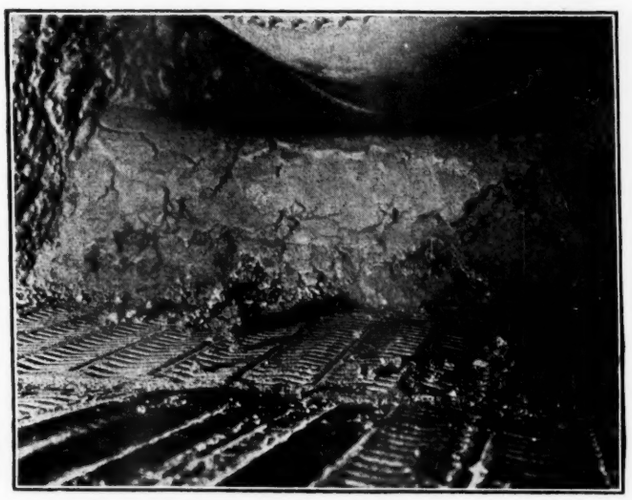


FIG. 2. FURNACE PREPAIRED WITH FIRECLAY

conditions for ten months when the photographs were taken.

The cement is delivered by the S. Obermayer Co., Pittsburgh, Penn., in a dry state and is moistened when about to be used. The firebricks do not require moistening when using this cement. When applying it the bricks are laid with a close joint and the work is completed with a coat of cement applied with a stiff brush

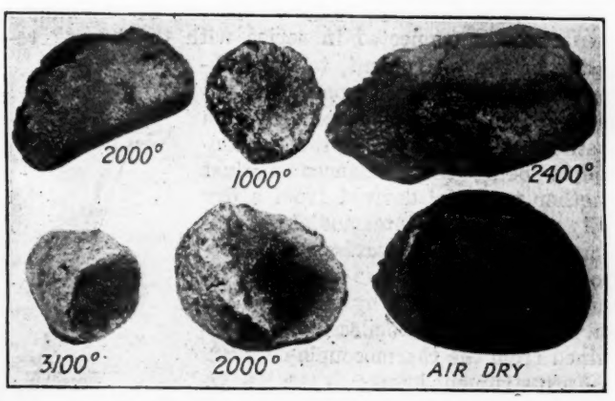


FIG. 3. "HOT PATCH" AS IT APPEARS UNDER DIFFERENT TEMPERATURES

to the face of the brickwork. This forms a glaze and prevents air seepage through the bricks and also protects them from the furnace heat. About 350 lb. of cement is required per thousand 9-in. brick.

Fig. 3 shows the appearance of the cement under different temperatures.

The Fuels Section of the Bureau of Mines is now engaged in an investigation of what actually happens in the combustion space of a powdered-coal-burning furnace, with particular reference to the ash disposal and furnace maintenance.

Brown Precision Heatmeter

Until comparatively recently, the determination of furnace and kiln temperatures by means of thermocouples was attended with complications and difficulties that made practical men, in some instances, doubtful in

PORTABLE PRECISION HEATMETER

regard to the intrinsic value and reliability of the method.

Various devices and attachments have been made for use in connection with indicating and recording millivoltmeters and pyrometers, by means of which the instruments will remain direct-reading and at the same time be compensated for external or line resistance. Inventions of this class range all the way from a simple step rheostat connected in series with the "dead" resistor of the instrument, to the elaborate and complicated apparatus employing the substitution and deflection methods, the potential of the thermocouple being first balanced against another potential derived from a dry cell; and after an intermediate operation and an intercomparison of deflections, the effect of line resistance is finally balanced out by means of a rheostat, and direct deflections are obtained from the thermocouple current.

An instrument known as the Brown Precision Heatmeter, made by the Brown Instrument Co., Philadelphia, Penn., eliminates the effect of line and thermocouple resistance by means of a simple operation. In testing with this apparatus all that is necessary is to connect the thermocouple with the instrument binding posts in the usual manner, press a button, turn a knob and take a reading, which will be the correct electromotive force of the thermocouple at its hot end, even if the line is miles in length. In fact, the line may have as much as 15 ohms resistance.

This instrument is direct-reading throughout its entire scale range, requires no dry cells or standard cells, is independent of line or thermocouple resistance and has a negligible temperature coefficient.

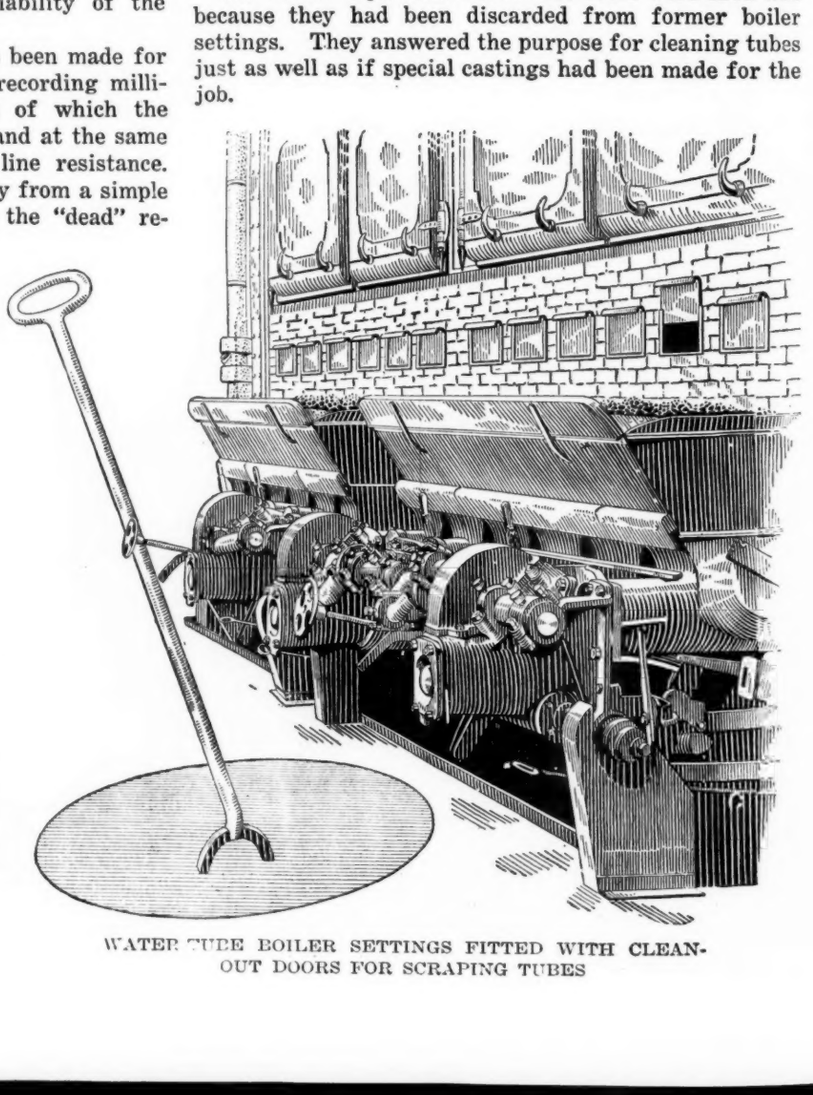
Cleaning Boiler Tubes of Outside Deposits

Engineers are familiar with the growth of ash deposit that accumulates on the first and second rows of tubes of water-tube boilers, especially where stokers are used and the boilers are run at capacity and over. The problem is to keep the outside of the tubes clean without cutting the boiler out of service while doing the work.

An interesting method of doing this work has been in use for some time at the Pratt Street Station of the United Electric and Railway Co., Baltimore, Md. In the front of each boiler setting, above the stoker coal hoppers of six water-tube boilers, six superheater clean-out doors have been built in the front brickwork, as shown in the illustration.

The boilers are 18 tubes wide, and each clean-out door permits of cleaning three tubes wide with a suitable tool, such as shown in the foreground. The scraper is made with a 4-in. radius to conform to the diameter of the boiler tube. It is fitted to a length of 1-in. pipe with a handle at the outer end. When cleaning tubes, one of the clean-out slides is lifted and the scraper end is pushed along the tubes, thus removing the accumulation of ash and clinker deposits.

The reason superheater clean-out doors were used was because they had been discarded from former boiler settings. They answered the purpose for cleaning tubes just as well as if special castings had been made for the job.



WATER TUBE BOILER SETTINGS FITTED WITH CLEAN-OUT DOORS FOR SCRAPING TUBES

EDITORIALS

Publisher's Note

Owing to the unexpected prohibition of overtime by one of the printing trades in New York City this week, it has been necessary to cut down the number of pages in the present issue.

Coal-Saving Dopes

EVERY little while somebody appears with a compound which, dissolved in water and sprinkled upon coal, is alleged to produce a saving of from ten to fifty per cent.

Power has published analyses of many of these and has pointed out repeatedly that nothing that costs less than more coal is available to add to the heat value of the fuel. But still these compounds are invented and launched, and people buy them and use them and testify to savings effected by their use. You cannot argue against that kind of evidence, as Fra Hubbard said in his dispute with Ali Baba about the pebbles. Ali maintained that boulders were simply grown-up pebbles, and, when Hubbard expressed incredulity, said: "You see that rock over there. Well, I knew it when it wasn't more than so big."

What argument is there ag inst that kind of a stand? These people have tried the dope and burned less coal, and they know it. They would have burned less coal if they had used toilet water. There are few plants, especially house-heating plants, in which material savings cannot be made by convincing the operators that they are going to make a saving and getting them to watch their step. If sprinkling the coal pile with some of this dope dissolved in a watering can would produce a positive and sustained saving of even five per cent., it would be in universal use. Yet we do not know of one of these compounds that has been launched with so much hope and enthusiasm and promise that has enjoyed more than a brief and stimulated existence.

A prominent consulting engineer has recently put his name to a report testifying to a considerable saving by the use of a compound of this kind. The test was made upon a house-heating boiler, and a weighed quantity of treated coal would last longer than the same weight of the same coal untreated. He lays this effect to the fact—which, he says, repeated experiment established—that the treated coal burned more freely than the untreated. A draft that would keep the treated coal burning at a rate sufficient to keep up the desired temperature in the heating system would not keep the untreated coal alight, but with the greater draft required to keep it from going out, the untreated coal burned up more quickly than the treated with less draft.

When the reopening of the Rhode Island coal mines was attempted some years ago, a chemist by the name of Williams offered a substance which he claimed would make this hard graphitic coal burn more freely, and experiments with the substance stirred into a crucible with Rhode Island coal, or even pure graphite, seemed to show that there was such an effect. If this can be proved, it may be responsible for such savings as would be brought about by the use of a freer-burning coal with an apparatus not well adapted to the use of a hard coal.

The latest example of this sort of a compound is Coal-Life, which is being exploited in Vancouver. Its analysis shows 29 parts in 100 by weight of common salt, 24 of washing soda, about 22 of caustic soda and about 9 of lime. The rest is moisture and impurities—alumina, silica, and iron—the sum of the impurities being about one and one-half per cent.

Control in Power Plants

WITH respect to control of equipment in power plants considerable progress has been made since the days of not so long ago. Not only has automatic control supplanted hand control where practicable, but hand-manipulated control has in large measure given way to electrically and hydraulically actuated control.

The automatic feed-water regulator is not new, yet it is only within recent years that it has been recognized as not only a reliable but a valuable adjunct to a boiler. One of the great advantages of the automatic feed-water regulator is that it gives a lag between flow and load, which promotes a more uniform boiler pressure and conduces to less loss of heat immediately after a marked sudden decrease in load. The engineers of large plants are finding that in this respect they are far superior to the hand control of water tenders.

It made an inspiring picture—that where the brave man in overalls rushed through a cloud of steam to close a valve back of a hissing, roaring leak. Sometimes he never reached the valve; he was cooked in his tracks. That day is no more. It is gone the way of the obsolete. In the modern plant the engineer or responsible subordinate merely steps to the wall, presses a button—and presto, a motor on the valve spins it shut. Perhaps a break has occurred in a line or machine which, if unchecked, would cripple the station. Press the button and isolate the affected section; the remainder of the plant hums along undisturbed.

This latter system is one of the features of the new extension to the famous L Street Station of the Edison Electric Illuminating Company of Boston. In the course of a few weeks we expect to publish a description of this new station. Mr. Dean, the inventor of the system, will himself tell about the remote control of valves in this plant.

Here in this station combustion control is as nearly perfect as every essential means can make it. The boiler room doesn't look like a boiler room, as one visualizes such.

The United States spends over half a billion dollars annually on general education, but practically nothing toward the making of skilled mechanics. Our factories average little over fifty per cent. efficiency. Wherever established, industrial training became a revenue by reducing the labor turnover and making production cheaper in the training department than elsewhere in the factory.

Correspondence

Why the Atmospheric Line?

I beg to differ with W. L. Trill in his explanation of the atmospheric line (Sept. 9 issue of *Power*, Page 439).

Referring to M. J. Ile's diagrams (Aug. 12 issue of *Power*, Page 269), it will be noticed that the atmospheric line is not at the same height in all the diagrams, due no doubt to part of the pressure having got away either by condensation or leakage before he drew the atmospheric line.

If he was using a three-way cock, the handle in either extreme position would be open only to the engine cylinder. When the handle is in the *central* position, the indicator will be open to atmosphere through a small hole in the side of the three-way cock. Mr. Iles will probably find this passage gummed with oil, which would prevent the release of pressure in the indicator cylinder.

If he was using a straight-way cock, he may have turned the cock in the wrong position in closing, which would allow the steam pressure to blow through the vent, instead of relieving the indicator of pressure.

Claremont, N. H. I. F. RICHMOND.

I would like to state my ideas formed by experiences similar to Mr. Iles'. I have had this same thing occur several times with several engines, and I will mention as many different causes as I have so far found.

I do not believe the position of the atmospheric line is caused by a sticking piston, as the diagrams show that the piston dropped very smoothly when tracing the expansion and exhaust lines, and with a 70-lb. spring the chances of sticking would be remote.

My troubles of this kind were caused by a leaky three-way cock, in one case, which maintained a pressure on the piston of the indicator while tracing the atmospheric line. In another case the vent hole in the bottom of the three-way cock became clogged, which prevented the steam escaping from the indicator cylinder after the cock was thrown to mid-position, closing off both ports.

In another case, where only gate valves were used the same thing occurred when the valves became leaky, and I have also had it happen when using single straight cocks which leaked and with straight cocks that had no vent to the atmosphere when closed.

As I do not know just what kind of valves or cocks Mr. Iles has in service for controlling the steam between his engine cylinder and his indicator, it would be hard to tell just what causes his trouble, but any of the aforementioned conditions will do it.

Webster, Mass. L. M. REED.

I am of the opinion that the three-way cock leaks when in mid-position, allowing the pressure to accumulate to the extent shown. If a three-way cock is not used, then one or the other of the valves in the piping from the ends of the cylinder was leaking when the atmospheric line was drawn. Remove the indicator with card intact from the cylinder and draw the atmospheric line by pulling the cord by hand, and it will be in its proper position.

Sometimes a simple indicator cock is used. This cock has an atmospheric outlet in the shape of a small hole in one side. If the valve is turned so that the steam that has accumulated in the piping after the valves at the ends are closed can escape through the small hole, the atmospheric line will be drawn correctly.

Louisville, Ky. JOHN F. HURST.

In regard to Mr. Iles' indicator diagrams, with the limited information in regard to where the engine exhausts, I would say from the looks of the diagrams that his engine must exhaust into a closed heater where there is a partial vacuum formed, which causes the atmospheric line to show a vacuum. It looks as if the condition under which the engine exhausts is not the same at all times, as the atmospheric line is not the same in each diagram.

Canton, N. C. C. A. SMITH.

Saved $20,000 on Yearly Coal Bill

I came to my present position as chief engineer in October, 1917, and began needed alterations the next June after the heating season was over. I figured I would save at least 1000 tons of coal, but never dreamed of saving 2000 tons yearly. I believe most engineers would do as well as I did if they would leave their power houses in their spare time and trace their steam lines and return pipes and find out where the steam is going after leaving the power house and if used efficiently. Practically all changes were made away from the power house, and the greatest improvement, and what I believe saved us the most coal, was due to changing the steam traps on the radiators and installing new traps on the cooking utensils.

The plant consists of two 125-hp. and four 75-hp. return-tubular boilers; one steam engine, directly connected to a 110-volt d.c. generator and a rotary converter for purchased a.c. power at a voltage of 550, reconverting to 110 volts d.c. The power purchased averaged about 100 kw., and the service demanded 125 kw. during the day and about 60 kw. during the night. Heating service was required for 60,000 ft. of radiation, the returns of which were carried back to the power house by a vacuum pump. Forty thousand feet of this heating system was equipped with obsolete traps, and 20,000 ft. had no traps at all, using only two master traps. A 35-hp. ice machine operated at a voltage of 110 volts d.c. There were also 40 steam cooking appliances using steam at 75 lb. with no steam-trap equipment; the condensation flowed to a master receiver and pump and returned to the power house. A laundry, with a set of belt-driven, out-of-date machinery with four large stationary dry racks washed and ironed 15,000 pieces a week.

The 40,000 ft. of the heating system that was equipped

with obsolete traps was reëquipped with modern traps, and the 20,000 ft. that had no traps, was equipped with modern traps. It was found in many cases that the parts of the old traps had been removed, and the steam was blowing through.

The steam-cooking apparatus was equipped with a valve for reducing the steam from 75 to 20 lb., and each piece of apparatus was given its own individual steam trap, doing away with the steam pump and receiver, the condensation being allowed to flow by gravity to the power house. In making this change we found several cases where, after the steam was allowed to flow through the steamers at 75 lb. pressure, the exhaust was allowed to escape to the atmosphere. A reducing valve was connected to these steamers, the pressure was reduced to 5 lb., and the exhaust was piped to the heating system. I figure that this change alone saved us a ton of coal a day.

A 550-volt a.c. motor was purchased for the ice machine, and the power was taken direct from the transformers instead of, as formerly, from the rotary converter. This allowed us to carry all the day load on the converter, and to shut down the steam engine, saving about three tons of coal daily for the summer. An economizer was purchased, and all the flue gases were utilized, thereby raising the temperature of the feed water for the boilers, making a saving of about 5 per cent. of the coal consumed.

The hot water that was used for domestic purposes was heated in heaters that had no trap or receiver equipment, and the condensation was allowed to flow to the drain, thus wasting thousands of pounds of water at a temperature of 145 deg. F. This was overcome by installing a pump and receiver for returning the condensation to the boilers.

A new set of modern direct-connected motor-driven laundry machinery was purchased, which we figure saves at least a ton of coal daily.

These changes cost $10,000 and save us 2000 tons of coal yearly, based on the consumption of 6000 tons yearly for the last three years. The coal cost us $10 per ton delivered to the bunkers. The investment was well worth the money spent on improvements as it will make a saving of $20,000 yearly. F. J. DOWLING.

Montreal, Canada.

The Fusing Temperature of Ash

In the article on page 332, Aug. 26 issue, by E. D. Hummel, entitled "Coal Analyses Made at the Power Plant," formula (2) shows that the percentage of volatile matter in the coal is the weight of residue divided by the weight of the sample and multiplied by 100. I presume the obvious fact that this should be loss of weight divided by weight of sample and multiplied by 100 has already been called to attention.

On page 354 L. J. Joffray, general fuel inspector of the Illinois Central R.R. discusses "Dirt in Coal." In Table II he gives analyses of ash and gives the fusing temperature of each of the various constituents of coal ash. He then draws the conclusions as to the effect of high sulphur and lime in causing low fusing points of the ash. Since his values for the fusing points of the various constituents are for the most part miles off, this alone would seem to discount his conclusions.

The Bureau of Standards and the United States Geophysical Laboratory give the following values for the fusing points of several constituents: silica oxide (SiO_2), 2957 deg. F.; aluminum oxide (Al_2O_3), 3722 deg. F.; calcium oxide (CaO), 4658 deg. F.; and magnesium oxide (MgO), 5072 deg. F. I have not been able to obtain their value on iron oxide (Fe_2O_3) and consequently cannot dispute his value on that.

I might say further that Mr. Joffray can draw only very general conclusions at best, even if his separate values were correct, as to the influence of the composition of the ash on the melting point, since he did not actually determine the ash-fusing point on each sample. The Bureau of Mines has done a large amount of accurate work on the subject of ash fusion and has come to the conclusion that the melting is a complex process. It does not amount to the successive melting points of the various constituents of the ash, but of a series of solutions of one compound in another, and of the continual formation of new compounds of different fusing points. The bureau has been unable to correlate the fusing points with the percentage of each constituent present in a given sample of ash.

The samples of coal ash upon which the bureau drew its conclusions came, not only from all parts of the United States, but from England, China and Alaska and represented every class of fuel from anthracite down to peat; while Mr. Joffray drew his conclusions on ten samples of bituminous coal, all from one state.

While most of the points brought out in his article are good and are well worth serious consideration on the part of every large consumer of coal, it seems to me that he has jumped at conclusions on the fusing proposition with too little knowledge of the subject.

WILLIAM J. RISLEY, JR., Chemist
Decatur, Ill. McLaughlin Coal Reduction Co.

Water in Superheaters

In answer to F. L. Richards, in the July 29 issue of *Power*, I wish to state that most superheater manufacturers install a drain on their superheaters and advise draining off all water before firing up the boiler.

This also applies when a boiler has been subjected to a hydrostatic test. While a superheater may be full of water when a boiler is fired up, it should, under normal working conditions, have all the water evaporated into steam before the boiler is cut in on the line. Probably no harm would be done the superheater in either case; however, it is not a water container but is designed for steam.

The only objection to water in superheaters when firing up is that it may be carried over in the steam line when the boiler cuts in on the line.

Sewickley, Penn. C. E. ALDRICH.

Engine Dashpot Oil

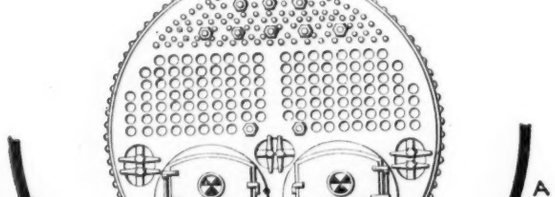
I have charge of a 16 x 18-in. automatic engine, speed 160 r.p.m. When I first took charge the dashpot was empty, so I used a mixture of half cylinder and half engine oil, which worked very well, but it was necessary to adjust the filling plug, which could be screwed down and cut off the bypass from one end of the dashpot to the other end. After a few trials the proper adjustment was found.

When the dashpot was disconnected, the eccentric would pound on the shaft, with the danger of breaking the eccentric casting. I tried cylinder oil alone, but it proved to be too stiff. MILLARD KURTZ.

Oakland, Calif.

Why Does One Seam Groove More Than Another?

The following is submitted in answer to A. Bennett's question on page 75 of the July 8 issue of *Power*, as to what may be the cause of grooving at the longitudinal seams of Lancashire or Cornish boilers. Mr. Bennett observed that whenever the bottom sheet of the boiler lapped over the outside of the shell, as at *A* (see



JOINT *B* GROOVES. JOINT *A* DOES NOT

illustration), no grooving took place, but with the bottom sheet placed inside of the shell, as at *B*, grooving was found in all stages.

It is common knowledge that in Scotch-marine boilers there is a reduced circulation of water below the level of the grates in the furnace. The heat, being applied to the water from the top downward, virtually eliminates convection. There remains only the conduction of heat through the water, and as the feed water also enters into this cool zone, the lower 20 per cent. of the contents of the boiler remain comparatively cool.

While the boiler is in full operation, the bottom sheet will have a materially lower temperature than the rest of the shell. At 200 lb. gage pressure saturated steam has a temperature of 388 deg. F. and the feed water is probably 200 to 300 deg. lower. The bottom sheet will therefore tend to retain its original shape, while the upper part of the shell, under the influence of high pressure and heat, seeks to increase its diameter.

When the bottom sheet is riveted to the inside, as at *B*, the tendency is to open the seam, allowing water to enter, thus imposing a strain on the rivets. If, however, the bottom sheet is placed at the outside of the shell, as at *A*, the tendency is to close the seam tighter, allowing no water to enter the joint and putting but very little strain on the rivets. Moreover, at *B* there is an opportunity for sediment to concentrate and lie indefinitely upon the shelf formed by the top edge of the bottom sheet, thus favoring corrosion; at *A* there is no such opportunity.

This theory may be the explanation for the phenomenon reported by Mr. Bennett. At any rate it seems advisable to place the bottom sheet at the outside of the shell rather than at the inside.

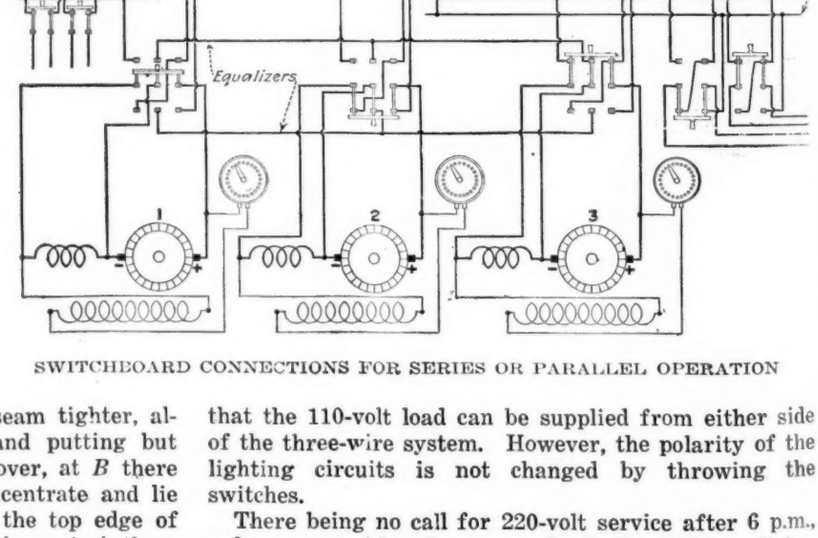
There are several methods for improving the circulation in Scotch-marine types of boilers. Some consist of inserting curved aprons or division sheets, etc., between the furnace flues and the boiler shell up to the tubes so as to guide and separate the warm ascending column of water from the cold descending column. This does away with cold dead water in the bottom of the boiler and should also counteract the grooving at the lap seams complained of. CHARLES H. HERTER.

New York City.

Series-Parallel Wiring for 110- or 220-Volt Service

A small power plant that had been used to supply light and power services at 110 and 220 volts had been changed over to supply 110 volts only. This plant was recently taken over by another firm, and it was decided to supply all services again from the one station instead of buying 220-volt power. The illustration shows the busses and also the main switches and connections. It will be seen that, with generators Nos. 2 and 3 connected as shown, generator No. 2 is supplying 110-volt power to busses *A* and *N*, and generator No. 3 is supplying 110-volt power to busses *N* and *B*. This connects the two generators in series across *A* and *B*, thus giving 220 volts across these two busses. The laminated type of bus is used, and where loads are likely to increase they will be found of great advantage, as copper bars can be added at any time.

Auxiliary power and lighting busses were put in to save loading up the main busses. All power switches installed are of the single-throw double-pole type, and the lighting switches are all double-throw double-pole. The lighting switches are connected to their three-wire busses, the switches being cross-connected as shown, so



SWITCHBOARD CONNECTIONS FOR SERIES OR PARALLEL OPERATION

that the 110-volt load can be supplied from either side of the three-wire system. However, the polarity of the lighting circuits is not changed by throwing the switches.

There being no call for 220-volt service after 6 p.m., only one machine is run and all the light switches are thrown to two busses. It is proposed later on to put in the three-wire system to all the buildings supplied from this plant, but as the two-wire installation was in operation and the price of material is still high, this work is being held over. No trouble has been experienced since the change over was made.

Cambridge, Mass. J. A. CAMPBELL.

Inquiries of General Interest

Testing Cylinder Oil for Tarry Ingredients—How can a cylinder oil be tested for tarry residue? P. M.

Dissolve one part of the oil in about twenty parts of gasoline. Allow a sample to stand for an hour in a clean test-tube and the tar or other insoluble matter will collect on the bottom of the test-tube.

Dry-Kiln Couplings—What is the difference between dry-kiln and common pipe couplings? R. H.

In dry-kiln heating it is of importance that no leaks develop in the steam pipe or joints, or the contents of the kiln may be seriously damaged; and to insure against bad joints, pipe couplings of extra-heavy weight and length are used, and couplings of the kind are known as dry-kiln couplings.

Removing Burnt and Gummy Oil—What will clean burnt oil from the top of a steam chest and cylinder head of an engine? W. R. T.

Burnt and gummy oil can be removed with a strong lye water, made of about a pound of potash to a half bucket of water. Remove the cylinder head and lay it down with the face covered over for ten to fifteen hours with waste or cloths saturated with the lye water and apply the wash in the same manner to the top of the steam chest. This will soften the dirt so it can be readily scraped off the surfaces, which can then be cleaned up with sandpaper and brightened with oil and emery cloth.

Power Transmission for Difference in Belt Tension—What would be the difference in tension on the tight and the loose side of a belt traveling 1200 ft. per min. to transmit 6 hp.; and what number of horsepower would be transmitted with the same difference in tension for a belt speed of 400 ft. per min.? M. D.

Transmission of 6 hp., or $6 \times 33{,}000 = 198{,}000$ ft.-lb. per min., at a speed of 1200 ft. per min. would require a difference of tension of $198{,}000 \div 1200 = 165$ lb., and a belt speed of 400 ft. per min. with the same difference of tension would transmit $\frac{400}{1200}$ of 6, or 2 horsepower.

Bending of Water Tubes—In erecting a water-tube boiler the weight of the front end was supported on planks inserted between the rows of tubes, and a few days after the boiler was put in use the tubes showed considerable buckling out of line. Would not this be attributable to the method of handling the boiler when erected? J. H. W.

It is not likely that supporting the boiler in the manner stated would occasion bending or buckling after use unless the deformation was perceptible before the boilers were fired. Bending of water tubes is often the result of overheating and sometimes occurs with most careful handling and use of a boiler. An explanation given is that in use one side of the tube becomes hotter and expands more than the other, resulting in a condition of an eccentrically loaded column, causing the tube to bend away from the longer side. With a tube once bent from inequal expansion, the deflection becomes more pronounced from use.

Appropriate Width for Double Belt—What width of open double leather belt would be suitable for transmitting 164 hp. from a 72-in. diameter driving pulley to a 26-in. diameter iron receiving pulley that is to make 650 r.p.m. with pulleys spaced 17 ft. 9 in. horizontal centers? R. P. H.

For reasonable service and durability it would be suitable to provide good-quality double leather belting on the basis of capacity for transmission of 1.8 as much as single belting, and rate the transmission appropriate per inch width of single belting as 1 hp. per 785 ft. travel per min., or 1 hp. per inch width of single belt on a 30-in. diameter pulley making 100 r.p.m. For the conditions stated this would require a double belt $\frac{164 \times 30 \times 100}{1.8 \times 26 \times 650} =$ about 16 in. wide.

Hammering of Geared Feed Pump—We are troubled with hammering of a geared triplex pump used for feeding hot water that is supplied from an open tank under a head of about three feet. Where should we look for the cause, and how can it be remedied? W. L.

It is probable that the pump is driven too fast for the pump chambers to become filled on account of length of suction pipe or small size of pipe and passages, which results in slippage of the pump on the suction strokes and hammering when the plungers come down on water that fills only a portion of the cylinders. If the pump is belt-driven and it is not otherwise convenient to try it out with slower speed, note whether the hammering stops when the speed is slowed down with the belt slipping from being thrown partly on the loose pulley.

Chimney Capacity for Greater Height and Smaller Flue—A stack having a flue 36 in. in diameter is 78 ft. high. How much will the capacity be increased if the height is increased to 100 ft. with the size of flue reduced to 34 in. in diameter at the top, and what will be the increase in force of draft? J. N. L.

For the same temperature of chimney gases the force or pressure of the draft at the base of the chimney will be directly as the height, or $(100 - 78) \times 100 \div 78 =$ about 28 per cent. greater, thereby permitting use of a lower grade of fuel. The discharge capacity is directly as the square root of the height and about proportional to the area, so that the boiler capacity with the proposed dimensions would be to the present capacity as $34 \times 34\sqrt{100}$ to $36 \times 36\sqrt{78}$, or only about 1 per cent. greater.

Horsepower of a Return-Tubular Boiler—What is the horsepower of a horizontal return-tubular boiler 6 ft. in diameter by 17 ft. long, containing 72 four-inch tubes? F. C.

In rating the horsepower size of a boiler from its dimensions, it is the general practice among builders and engineers to allow 10 sq.ft. of heating surface per horsepower, and to consider as heating surface all the surfaces that are surrounded by water of the boiler on one side and by flame or heated gases on the other, using the external instead of the internal diameter of tubes for greater convenience of calculation. For horizontal return-tubular boilers, it is customary to allow that the heating surface consists of two-thirds of the cylindrical shell, the sum of the internal areas of all tubes and two-thirds of the net area of the tube sheets. Reduced to inches, the dimensions of the boiler would be 72 in. in diameter by 204 in. long and the allowable heating surface would be:

Shell:	$\frac{2}{3}$ of $72 \times 3.1416 \times 204 =$ 30,762 sq.in.
Tubes:	$4 \times 3.1416 \times 204 \times 72 =$ 184,575 sq.in.
Heads:	
$\frac{2}{3}$ $(72 \times 72 \times 0.7854)$ 2 − $(4 \times 4 \times 0.7854)$ 72 =	4,524 sq.in.
Total	219,861 sq.in.

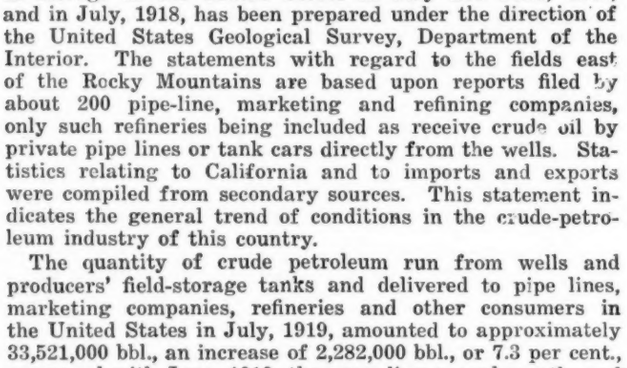
or 219,861 ÷ 144 = 1,526.8 sq.ft. of heating surface, making the size of the boiler 1,526.8 ÷ 10 = 152.68 hp.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. —Editor.]

Crude-Petroleum Situation in the United States

A comparative summary of the quantity of crude petroleum produced and marketed, imported, exported, and held in storage in the United States in July and June, 1919, and in July, 1918, has been prepared under the direction of the United States Geological Survey, Department of the Interior. The statements with regard to the fields east of the Rocky Mountains are based upon reports filed by about 200 pipe-line, marketing and refining companies, only such refineries being included as receive crude oil by private pipe lines or tank cars directly from the wells. Statistics relating to California and to imports and exports were compiled from secondary sources. This statement indicates the general trend of conditions in the crude-petroleum industry of this country.

The quantity of crude petroleum run from wells and producers' field-storage tanks and delivered to pipe lines, marketing companies, refineries and other consumers in the United States in July, 1919, amounted to approximately 33,521,000 bbl., an increase of 2,282,000 bbl., or 7.3 per cent., compared with June, 1919, the preceding record month, and of 3,160,000 bbl., or 10.4 per cent., compared with July, 1918. The average daily rate in July, 1919, was 1,081,323 bbl., a quantity greater by 40,023 bbl., or about 4 per cent., than the average daily rate in the preceding month, and by 101,936 bbl., or about 10 per cent., than the average daily rate in the corresponding month of last year. This notable increase, though in part seasonal, is ascribed largely to improved conditions in the market for drilling equipment, to continued high prices for oil and to the stimulation given to the quest for petroleum during the war.



ESTIMATED MONTHLY FLUCTUATIONS IN AVERAGE DAILY RATE OF CONSUMPTION AND PRODUCTION AND IN STOCKS OF DOMESTIC CRUDE PETROLEUM IN 1918-19, IN BARRELS OF 42 GALLONS

It is estimated that 98 per cent. of this oil was actually brought to the surface in the United States in the months specified, the remaining 2 per cent., consisting of runs or tank-car shipments from field storage. Data concerning the quantity of oil run into field storage are not available.

About 27,425,000 bbl. of domestic crude petroleum was delivered in July, 1919, to refineries and other consumers of crude oil and used for the manufacture of petroleum products and for fuel, or exported. This quantity is less by 333,000 bbl., or 1.2 per cent., than the quantity so delivered or consumed in June, 1919, and 5,826,000 bbl., or about 17.5 per cent., than the consumption in July, 1918. The average daily rate of consumption was 884,677 bbl., a decrease of 40,590, or about 4 per cent., compared with the daily rate in June, 1919, and of 187,936 bbl., or about 17.5 per cent., compared with the rate in June, 1918.

The notable increase during July, 1919, compared with the corresponding month of last year, shows the salutary effect of the termination of the war upon the surface reserve of domestic petroleum.

The United States leads the other countries of the world in the production of crude petroleum, but the quantity obtained from domestic sources is inadequate to meet the demand, and a large volume is imported, chiefly from Mexico.

Although the exports of the petroleum industry in the United States consist chiefly of refined products, a substantial volume of crude oil is being exported for the manufacture of petroleum products in Canada, Cuba and other foreign countries. The exports for July, 1919, totaled 205,642 bbl., for June of the same year 254,000 bbl., and in July 476,856 bbl., or more than was exported in both June and July of the previous year. The imports for July, 1919, were 4,487,652 bbl., for June, 1919, 4,728,141 bbl., and July, 1918, 2,832,786 barrels.

The following table was compiled from the records of the Bureau of Foreign and Domestic Commerce:

IMPORTS AND EXPORTS OF CRUDE PETROLEUM

(Barrels of 42 Gallons Each)

	July, 1919	June, 1919	July, 1918
Imports—Source:			
Mexico	4,462,910	4,703,212	2 817,702
Other countries	24 742	24,929	15,084
	4,487,652	4,728,141	2,832,786
Exports—Destination:			
Canada	188,261	254,209	454,838
Cuba			10
Mexico	774	79	280
Other countries	16,607	182	21,728
	205,642	254,470	476,856
Excess of imports over exports	4,282 010	4,473,671	2,355,930

Delay Faces the Water-Power Bill

In all probability the water-power bill must await the disposal of the peace treaty before it can be brought up for consideration on the floor of the Senate. Senator Jones of Washington, chairman of the Committee on Commerce, has made every effort to secure permission for the consideration of the bill during such times that the Peace Treaty was not actually before the Senate. This plan was defeated, however, by Senator Lenroot of Wisconsin, who opposes the bill. As it is conceded that Senator Lenroot probably could prevent any headway with the bill while the treaty was before the Senate, Senator Jones practically has agreed to await the disposal of the treaty before calling up the water-power bill. He advised the Senate, however, that immediately following the vote on the treaty, he would try to keep the bill constantly before the Senate until it is disposed of. He fully expects the measure to pass before the end of the extra session.

The bill as reported to the Senate contains several changes in the text of the bill passed by the House. It is believed, however, that the House will not object seriously to any of the amendments that were made by the Senate committee. The one substantial change is the prescribing of principles to govern the commission in the fixing of annual charges. The House bill gives the commission unlimited power to fix charges. The Senate committee objected to giving a blanket power to tax the licensees and resulted in the insertion of the following amendment:

That the licensee shall pay for the license herein granted such reasonable annual charges as may be fixed by the commission, for the purpose of reimbursing the United States for the cost of administration of the act in relation to water powers developed under its jurisdiction, in the proportion that the water power developed by the project covered by said license bears to the total water power developed by all projects licensed under the act, and for that purpose such charges may be readjusted from time to time, not oftener than once in two years; the licensee shall also pay for the use and occupation of any public lands and lands in reservations except tribal lands embraced within Indian reservations necessary for the development of the project covered by the license such reasonable annual charges based upon the actual value of the Government lands used as may be fixed by the commission; but in no event shall the annual charge for the foregoing exceed 25 cents per developed horsepower: Provided, That when licenses are issued involving the use of Government dams or other structures owned by the United States or tribal lands embraced within Indian reservations the commission shall fix a reasonable annual charge for the use thereof, and such charges may be readjusted at the end of twenty years after the beginning of operations and at periods of not less than ten years thereafter in a manner to be described in each license.

A change was made in section 15 of the bill providing that in case the United States does not exercise the right to take over the works the license tendered shall be "on reasonable terms" and "which is accepted" by the original or the new licensee. That provision was thought necessary to make it certain that capital would invest under the law. The Senate committee changed the salary of the secretary of the commission from $5000 to $6000 a year and made various changes and additions to the language looking to clarification. In reporting the bill to the Senate, Senator Jones said:

It is unnecessary to point out the need for or the beneficent results to come from water-power development. It means a saving of coal and a lower price for that used; a saving of oil and a lower price for that consumed; more efficient transportation and lower cost of service; the development of new industries; the building up of new communities; the creation of new property values, subject to taxation for the support and maintenance of local and state governments; and added employment for labor and increased markets for agricultural products. Every year that our water power is undeveloped means a loss to the people in one form or another, almost, if not quite, equal to the cost of their development. Legislative action should be delayed no longer. We should do one of two things: We should pass legislation that will lead private capital and enterprise to develop these resources under such regulations as will give consumers good service and cheap power or the Government itself should proceed to make this development. This bill proceeds on the theory of private development with ultimate public ownership possible. While some of the fundamental provisions of this measure do not meet the approval of the members of the committee, we deem it wise to accept them in view of the legislative situation, rather than incur the result of no legislation on this important subject.

Government Investigates Salt Lake City Smoke

Salt Lake City has arranged for a thorough investigation of its smoke condition, which, in the winter time, has become so serious as to menace the health and comfort of the community. Owing to its location, surrounded as it is with a fringe of high mountains, the air currents for the greater part of the year are insufficient to carry away the smoke and gases and they hang like a pall over the city and constitute one of the greatest problems to be met in its municipal affairs.

The work will be done by the United States Bureau of Mines, in coöperation with the University of Utah, and will continue throughout the coming heating season, the Bureau operating under the provisions of the Sundry Appropriations Bill giving it authority to extend aid to cities interested in smoke abatement.

Osborn Monnett, consulting engineer, of Chicago, has been retained by the bureau to direct the work. Preliminary investigation having to do with the constant smokers started on Sept. 1, and the gathering of data will go on as the heating season progresses. The scope of the work will include not only smoke, but smelter gases, as well as all other forms of atmospheric pollution. A scientific study of the subject will be made, and complete recommendations for eliminating the smoke will be submitted after the investigation is finished.

In the preliminary investigation now under way, Ringelmann chart readings are being made of the smoke density from plants that have been constant offenders. In addition the amounts of coal being consumed by these plants are being obtained to give some idea of the amount of smoke made relative to the total smoke of the city. A fuel survey is also under way.

As the heating season advances, complete Ringelmann chart readings will be made on the residences, the smoke made by the different classes of domestic apparatus being determined to ascertain the seriousness of this class of offender as related to the entire problem. The large heating plants, such as apartment houses, hotels, etc., will receive attention as soon as they begin to smoke.

A soot-fall study is under way, deposits being collected in jars placed at 20 different points throughout the city. These jars will be collected periodically and the proportionate amount of deposit ascertained from month to month as the season progresses.

Preparation is being made also for a careful and scientific examination of the atmosphere throughout the season to determine the influence of smoke and of smelter gases. Laboratory apparatus is being used for taking and filtering air samples, the filtrate to be examined chemically and microscopically. The character of the atmospheric content will be determined for the different localities, such as residence, business, industrial, etc.

In studying the peculiar surroundings and local conditions of the city advantage will be taken of the assistance of the local weather bureau. Maps and charts, elevations and profiles will be gathered, together with wind velocities, humidity and other meteorological data having a bearing on the case.

It is proposed also to have a corps of demonstrators who will give personal instruction in the operation of domestic heating apparatus, with the idea of reducing smoke to the minimum. By students from the university, a canvass will be made of the types of equipment in use in the city and a special study of this equipment looking toward smokeless operation will be made. There are a number of furnaces, boilers, stoves, etc., now on the market that are supposed to operate smokelessly with soft coal. Tests of such apparatus using the local coals of the territory will be made to determine just how far they will go to eliminate the smoke nuisance.

With smoke reduction still in view experts will be sent to investigate the local deposits of anthracite in the State of Utah, and it is also proposed to investigate the low-temperature coking properties of the coals available in the city. Although low-temperature distillation has not been fully developed, it promises to be a great factor in solving the smoke problem of residence localities. In making low-temperature coke, a considerable amount of volatile matter is left in the fuel, which gives it a property akin to semibituminous coal, producing a fuel that is easily ignited and can be used by the average householder without special instruction. The value of byproducts from this process will receive attention, and the feasibility of the entire process will be considered as one of the possible solutions of the smoke problem.

The American Boiler Manufacturers Association

At its annual meeting at Buffalo in June the American Boiler Manufacturers Association voted to hold quarterly meetings. The first of these was held at the Hotel Astor, New York, on Wednesday, Sept. 24. The forenoon was devoted to discussing costs. The results of estimates on the cost of a horizontal-tubular boiler of standard design as computed by 22 different builders averaged $3819, and the estimates varied from 28 per cent. above to 14 per cent. below this price. Estimates upon some of the details varied widely and the discussion promised to be useful in unifying methods of figuring, the handling of overhead, etc. The afternoon was devoted to routine business.

The public hearing on proposed municipal regulations for storage and use of fuel oil in New York City, held Sept. 24 before the Board of Standards and Appeals, will be continued on Wednesday, Oct. 1, 10 a.m., in the rooms of the board, ninth floor of the Municipal Building. The session held on the 24th inst. covered consideration of permissible flash point and specific gravity for fuel oil; manner of storage; location of tanks in existing and new buildings; enclosure of tanks; capacity of tanks located within and without the fire limits, and materials of tank construction. Additional recommendations and suggestions under these heads will be received by the board Oct. 1, and consideration will be made of the subjects: Vent and fill pipes; feed systems; pumps and piping; controlling valves; heating to reduce viscocity; burners; auxiliary supply tanks; fire extinguishing equipment; operation of plant, and official approval of installations.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.40@2.90	$2.85@3.25
F. o. b. Philadelphia, gross tons	4.50@5.10	5.05@5.50
F. o. b. New York, gross tons	4.85@5.45	5.40@5.80
Alongside Boston (water coal), gross tons	6.75@7.60	7.50@7.75

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River quotations continue on the basis of 6.@6.50 per gross ton f. o. b. Norfolk and Newport News, but no sales are reported at these figures other than for export or bunker trade.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.30	$7.05
Egg	6.35	8.20	Buckwheat	3.40	5.15
Stove	6.60	8.45	Rice	2.75	4.50
Chestnut	6.70	8.55	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.70@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@2.90
Reynoldsville	2.85@2.90
Quemahoning	3.25@3.50
Somerset (medium)	3.00@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.65@2.75
Fairmont	2.50@2.65
Fairmont ¾ in.	3.10@3.25
Latrobe	2.75@2.90
Greensburg	2.75@3.00
Westmoreland ¾ in.	3.50@3.75
Westmoreland run-of-mine	3.20@3.35

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Anthracite Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.35	8.20	Rice	2.75	3.65
Stove	6.60	8.45	Boiler	2.50	3.50
Nut	6.70	8.55	Barley	2.25	3.15
Pea	5.30	6.90			

PITTSBURGH—Counting out occasional low and high priced sales involving but small tonnage, the great bulk of the transactions is quotable as follows, Pittsburgh District:

Steam:	Per Net Ton
Slack	$2.10@2.30
Mine-run	2.50@2.60
Gas:	
Slack	2.20@2.40
Mine-run	2.50@2.70
Prepared sizes	2.60@2.80

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.30@2.60	$2.30@2.60	$2.40
Black Creek and Cahaba	3.45@3.86	3.45@3.85	3.05
Jagger - Pratt Corona	2.85	3.00	2.45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	5.00@$5.50
Corona	3.50
Jagger	3.50
Montvallo	5.50@$6.00

Quotations on recent representative sales are as follows:

	Franklin County	William-son County	Spring-field	Norther Illinois
Prepared sizes	3.25	3.20	3.00	3.75
Mine-Run	2.70	2.50	2.30	2.30
Screenings	2.50	2.10	2.00	2.35

New Construction

PROPOSED WORK

N. H., Portsmouth—Spec. No. 4017, the Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing 1000 kw. turbo generator, at the Navy Yard here, from Rideout Chandler & Joyce, 178 High St., Boston, $9,066; Shevlin Engineering Co., 110 West 34th St., New York City, $10,540; Raymond R. Bill & Co., 55 Fort St., Springfield, Mass., $11,868. Noted Sept. 9.

Mass., Holyoke—H. L. Gendreau, Engr., 755 Gratton St., Willimansett, will soon receive bids for the construction of a 3 story garage on Race and Appleton St. A steam heating system will be installed in same. Total estimated cost, $125,000. Owner's name withheld.

N. Y., New York (Stapleton)—J. A. Wetmore, Supervising Architect, Treasury Department, Washington, D. C., received bids for the construction of a temporary boiler plant at the Marine Hospital here, from Almiral & Co., 1 Dominick St., $3245; John R. Proctor, 74 Courtland St., New York City, $3775; Austin Heating Corporation, New York City, $3965.

Pa., Philadelphia—G. C. Nimmons & Co., 120 South Michigan Ave., Chicago is receiving bids for the construction of a mail order plant, here, for Sears Roebuck & Co., Arthington and Homan Ave., Chicago, to consist of 3 buildings, one 9 story, 800 x 442 ft., one 6 story, 80 x 420 ft., and a power house. Total estimated cost, $4,500,000.

Pa., Pittsburgh—John Swan, Director of Department of Public Works, will soon award the contract for furnishing and delivering mechanical draft equipment including fan, engine, etc., at the Herron Hill Pumping Station. N. S. Sprague, City Co. Bldg, Engr.

Md., Annapolis—Spec., No. 4025, The Bureau of Yards & Docks, Navy Department, Washington, D. C., (late bid), received bids for installing 3 boilers in the naval academy here, from E. Keeler & Co., 238 West St., Williamsport, Pa., $37,249; H. E. Crook Co., 28 Light St., Baltimore, $40,325; Heine Safety Boiler Co., 1120 Pennsylvania Bldg., Philadelphia, $41,290; Babcock & Wilcox Co., 11 North American Bldg., Phila., $54,338. Noted Sept. 2.

Md., Annapolis—Spec. No. 4025, The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the construction of a power and boiler plant at the Naval Academy here. Total estimated cost, $45,000.

Md., Annapolis—Spec. No. 4026, The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids for the construction of an ash bunker and addition to power house. Estimated cost, $96,000.

S. C., Charleston—Spec., No. 4011, The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing 2500 kva. turbo-alternator at the Navy Yard here, from the Shevlin Engineering Co., 110 West 34th St., New York City, $25,680; Carroll Electric Co., 714 12th St., N. W., Washington, D. C., $27,335; Almiral & Co., No. 1 Dominic St., New York City, $37,526. Noted Sept. 9.

Ala., Birmingham—The Preston Motors Corporation plans to construct a 60 x 80 ft. power house in connection with proposed plant. R. A. Skinner, Pres. and Ch. Engr.

Ohio, Cleveland—The Martin Barris Co., 2048 West 3rd St., is having plans prepared for the construction of a 2 story, 36 x 165 ft. saw mill and power house. A steam heating system will be installed in same. Total estimated cost, $100,000. G. S. Rider, Century Bldg., Engr.

Ohio, Cleveland—The Vita Manufacturing Co., Williamson Bldg., is receiving bids for the construction of a 1 story, 132 x 252 ft. factory, on Madison Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Youngstown—The Board of Education, 20 West Wood St., will receive bids until October 6, for furnishing all material and installing a complete Miles Cabinet heating and ventilating system in the proposed U. S. Grant School, on the corner of Ridge Ave. and Edwards St. S. R. Creps, Dir. of Schools.

Mich., Detroit—The Board of Education, 50 Broadway Ave., received bids for the installation of heating, ventilating and plumbing systems in (a) Angell School, (b) Carstens School addition, (c) Trowbridge School addition, (d) open air school on Clippert site, (e) open air school, Davison Annex, from J. W. Partlan, Park Place, (a) $43,890, (c) $36,833; Irvine & Meier, 2289 Woodward Ave., (a) $48,599, (b) $52,051, (d) $6,512, (e) $7393; Drake Avery Co., 40 State St., (a) $49,217, (c) $40,715; W. J. Renolt, 506 Owen Bldg., (b) $51,051, (c) $40,325, (d) $18,397, (e) $8603; R. L. Spitzley Heating Co., Vinton Bldg., (b) $58,177; A. W. Schultz & Co., 815 Gratiot Ave., (d) $12,788, (e) $12,289.

Mich., Detroit—The Board of Water Commissioners, 232 Jefferson Ave., will soon award the contract for the construction of foundation and sub-structure for lift pumping station, placing of 1600 lin.ft. of electric conduit. Total estimated cost, $300,000. T. Aleisen, Engr.

Mich., Detroit—The Commissioner of Purchases & Supplies, Municipal Bldg., will soon award the contract for furnishing 16 single phase, oil insulated self cooling high efficiency type transformers for out door service, 60 cycle; 2 transformers 3300 volts primary 110-220 secondary, Scott connected to transform 3300 volts 3 phase to 110 and 220 volts, 2 phase; 14 transformers 2300-volt primary 115-230 volts secondary; two 75 kva., three 50 kva., two 40 kva., four 30 kva., four 30 kva. and three 5 kva.

Mich., St. Louis—H. B. Guilding, City Clerk, will soon receive bids for furnishing one generator set, 280 kw., 2300 volt, 3 phase, 60 cycle generator, coupled through reduction gears to condensing type steam turbine.

Wis., Sheboygan—The Vollroth Co. West Michigan Ave., plans to build an electric power plant and rebuild its heating system. Estimated cost, $50,000. Cahill-Douglas Co., 128 Grand Ave., Milwaukee, Engr.

Minn., Fairmont—The City Clerk will receive bids until October 7 for the construction of a 1 story, 83 x 83 ft. electrical power house. Total estimated cost, $175,000 A. Horone, Engr.

Minn., Minneapolis—The Minneapolis Sanitary Ice Co., 535 Metropolitan Bank Bldg., is receiving bids for the construction of a 1 story, 160 x 210 ft. ice factory on 29th St. Estimated cost, $75,000.

Wash., Fairview—(Seattle P. O.) A. Kristoferson Co., Eastlake Ave., plans to build a 2 story, 100 x 100 ft. milk plant, to include refrigerating plant, mechanical carriers, elevators, power plant and compressed air plant. Total estimated cost without equipment, $50,000. E. Story, New York Block, Seattle, Arch.

Wash., Seattle—The City Council will receive bids until October 8 for furnishing and installing condensers, pumps, 6 new boilers and a 10,000 kw. generator, for increasing Lake Union steam plant Total estimated cost, $1,250,000. D. Huntington, City Arch.

Ore., Stanfield—J. M. Kyle, Mayor, will receive bids until October 2 for furnishing labor and materials for the construction of a waterworks system and for the installation of a pumping system. Total estimated cost, $10,000. C. R. Hazen, City Clk.

Ont., Oshawa—B. H. Prack, Engr., Lumsden Bldg., Toronto, will receive bids until October 3, for the construction of a sheet metal products factory, consisting of 5 structural steel buildings for the Pedlar People, Ltd. Plans include a central heating and power plant, (direct and indirect systems will be used). Total estimated cost, $500,000.

Mex., Vera Cruz—Magrassi & Arzoni, Gutierrez Zamora, are in the market for a second hand substantial, 30 x 40 hp. crude oil or kerosene engine, in good condition.

CONTRACTS AWARDED

Mass., Worcester—The city has awarded the contract for the construction of a 2 story, 33 x 190 ft. hospital on Belmont St., to J. J. Roberts, 4 Wall St. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., Long Island City—The Gehnrich Indirect Heat Oven Co., 60 Franklin Ave., Brooklyn, has awarded the contract for the construction of a 2 story factory on Skillman Ave., to L. Gold, 44 Court St., Brooklyn. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. J., Newark—W. A. Swasey, Arch., 101 Park Ave., New York City, has awarded the contract for the construction of a 150 x 150 ft. theater on Broad and Rector St. to Norton, Bird & Whitman, 501 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $500,000. Owner's name withheld.